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Some Fruits and Nuts for the Tropics

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AGRICULTURAL RESEARCH SERVICE
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Some Fruits and Nuts for the Tropics

By

William C. Kennard and Harold F. Winters
Federal Experiment Station in Puerto Rico,
Mayaguez, P. R.

Miscellaneous Publication No. 801
AGRICULTURAL RESEARCH SERVICE
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SOME FRUITS AND NUTS FOR THE TROPICS

By William C. Kennard and Harold F. Winters, horticulturists,
Federal Experiment Station in Puerto Rico [1]

Since its establishment in 1901, the Federal Experiment Station at Mayaguez, Puerto Rico, has been actively engaged in the introduction and testing of tropical and subtropical plants from many parts of the world. Three circulars describing and illustrating some of the ornamental vines, shrubs, and large-leaved plants in this collection have been published (*31*, *32*, *79*).[2]

The present publication deals with the edible fruits and nuts in this collection. In addition, those that are native to or have become naturalized in Puerto Rico have been included. No attempt has been made to discuss all tropical and subtropical fruit and nut plants. The citrus fruits, avocado, papaya, mango, olive, date, coconut, and bananas are not included since they can be considered as major tropical fruits. Many articles about their growth, culture, and uses exist in the literature. For a discussion of these fruits the reader is referred to the publications by Chandler (*14*), Popenoe (*58*), Webber and Batchelor (*11*, *73*), and Ochse (*55*). Some additional minor fruits that could be included come to mind. For example, *Telfairia pedata* Hook. This is not included in the present publication since it has not been growing in the station collection long enough to have fruited or to have been thoroughly evaluated as to growth and fruit characteristics. Several other tropical fruits and nuts in the Mayaguez collection are in the same category.

The tropical and subtropical areas of the world are particularly well supplied with fruit and nut species. They vary greatly in flavor, shape, quality, and season of maturity; hence, they are of interest to fruit growers and homeowners in the Southern United States and in the tropical areas under the American flag. Similarly, horticulturists, both professional and amateur, throughout the Tropics and subtropics of the world stand to benefit by establishing trial plantings of these potentially important crops. Little is known about many of these plants, but some have commercial possibilities, especially after they have become known and a demand has been created.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 126.

Development of improved strains, either by selection or by controlled breeding, must be effected before commercial plantings can be undertaken with confidence. Systematic collection of information about cultural procedures also is essential to the program. Such effort can result in the commercialization of many of these fruits. The macadamia, for example, has progressed from an occasionally cultivated introduction to a sizable industry in Hawaii in the short span of about 30 years. The development of a market has engendered interest in other parts of the world having a climate suitable for macadamia culture, and it promises to become one of the most important nut species. Other examples could be cited and, of course, new ones will become established on a large scale as tropical and subtropical fruits are more thoroughly evaluated.

Fruits make an excellent addition to the diet from both the nutritional and the flavor points of view. Careful selection of the proper species and varieties will give a succession of fruits ripening throughout the year. The maturation season of the various fruits and nuts is given in table 1. These data were collected in Puerto Rico, particularly at Mayaguez where records have been kept for a number of years. Some of the plants described produce fruits only during a short period, whereas others produce fruits more or less continuously. The periods listed should be used only as a guide, since the great range of both temperature and rainfall in the Tropics often affects the time of fruit maturation.

TABLE 1.—*Maturation season of the fruits and nuts*

Scientific name of plant	Season of ripening				Fruit available—[1]
	Mar., Apr., May	June, July, Aug.	Sept., Oct., Nov.	Dec., Jan., Feb.	
Achras zapota	√				Most of the year.
Aiphanes minima			√		
Anacardium occidentale		√			
Annona cherimola				√	
A. diversifolia		√			
A. montana		√			
A. muricata		√			Most of the year.
A. reticulata	√			√	
A. squamosa		√	√		
Antidesma bunius			√		
A. platyphyllum			√		
Artocarpus communis		√			All year.
A. integra		√			Most of the year.
A. odoratissima		√			
Averrhoa bilimbi		√			
A. carambola		√			
Bertholletia excelsa	√				
Bixa orellana				√	Most of the year.
Blighia sapida		√			
Bromelia pinguin				√	All year.
Byrsonima crassifolia		√			
B. spicata			√		
Calocarpum sapota		√			
C. viride				√	
Carissa carandas		√			
C. edulis		√			

[1] Beyond season of ripening.

TABLE 1.—*Maturation season of the fruits and nuts (cont'd.)*

Scientific name of plant	Season of ripening				Fruit available—[1]
	Mar., Apr., May	June, July, Aug.	Sept., Oct., Nov.	Dec., Jan., Feb.	
C. grandiflora		√			
Casimiroa edulis		√			
C. tetrameria		√			
Chrysobalanus icaco		√			
Chrysophyllum cainito	√				
C. oliviforme	√				
Coccoloba floridana		√			
C. uvifera		√			
Cola acuminata			√		
Cyphomandra betacea				√	
Dillenia indica			√		Most of the year.
Diospyros discolor		√			Most of the year.
D. ebenaster		√			
Dovyalis abyssinica		√			All year.
D. caffra	√				
D. hebecarpa			√		All year.
Durio zibethinus		√			
Elaeagnus philippensis		√			
Eriobotrya japonica	√				
Eugenia dombeyi		√			
E. jambos		√			
E. malaccensis		√			
E. uniflora		√			
Euphoria longan			√		
Ficus carica			√		
Flacourtia indica			√		
F. inermis			√		
F. rukam				√	
Fragaria hybrids				√	
Garcinia dulcis		√			
G. livingstonei		√			
G. mangostana		√		√	
Genipa americana		√			All year.
Grewia asiatica		√			
Guilielma gasipaes		√			
Hibiscus sabdariffa	√				All year.
Inga laurina				√	
I. vera				√	
Lansium domesticum			√		
Lecythis elliptica		√			
L. zabucajo				√	
Litchi chinensis		√			
Lucuma multiflora				√	
L. nervosa			√	√	
Macadamia spp.		√			
Malacantha warneckeana		√			
Malpighia punicifolia	√	√			
Mammea americana		√			All year.
Melicocca bijuga			√		
Monstera deliciosa	√				
Morus alba			√		
Muntingia calabura	√				
Myrciaria cauliflora	√				
Myristica fragrans	√				
Parmentiera edulis			√		
Passiflora edulis		√	√		
P. edulis var. *flavicarpa*		√	√		
P. laurifolia		√	√		

[1] Beyond season of ripening.

TABLE 1.—*Maturation season of the fruits and nuts (cont'd.)*

Scientific name of plant	Season of ripening				Fruit available—[1]
	Mar., Apr., May	June, July, Aug.	Sept., Oct., Nov.	Dec., Jan., Feb.	
P. ligularis		√	√		
P. quadrangularis	√				Most of the year.
Pereskia aculeata		√			
Phyllanthus acidus	√				All year.
P. emblica	√				All year.
Psidium cattleianum f. *lucidum*			√		
P. guajava			√		All year.
P. guineense			√		Most of the year.
P. microphyllum			√		
Punica granatum	√				
Rheedia madruno		√			
Rollinia mucosa		√			
Rubus albescens	√				Most of the year.
R. florulentus	√				Most of the year.
R. glaucus	√				
R. probus				√	
R. rosaefolius	√				All year.
Sicana odorifera		√			
Solanum quitoense	√				
Spondias cytherea				√	
S. mombin		√			
S. purpurea			√		
S. purpurea var. *lutea*			√		
Sterculia apetala				√	
S. foetida				√	
Synsepalum dulcificum	√				All year.
Syzygium cumini		√			
Tamarindus indica			√		Most of the year.
Terminalia catappa				√	All year.
Theobroma cacao				√	
Triphasia trifolia	√		√		
Uvaria lancifolia			√		
Vangueria edulis				√	
Zizyphus mauritiana		√			

[1] Beyond season of ripening.

Some of the plants have particularly attractive foliage, and many are very showy when in flower. Some vines, such as the passifloras, can be used as coverings on fences and trellises, and the flowers are especially attractive. Other plants, such as the carrisas, form excellent hedges that flower and fruit in spite of the necessity for heavy pruning to maintain the desired shape. Some of the fruit plants form handsome specimen trees, which materially enhance the appearance of the home grounds and also provide shade if planted in the proper location. Regular spacing is desirable for commercial fruit plantings but is not necessary, nor even desirable, for home plantings. Care should be taken to consider the type of growth and the ultimate size of the plants selected so that they will fit into an overall landscape plan. Mention is made in the individual descriptions of those plants that make desirable ornamentals.

It is beyond the scope of this publication to list all articles pertaining to tropical fruits and nuts, but especially pertinent references are noted in the various descriptions. In addition to the books already listed, further information may be obtained from the following publications (*13, 21, 46, 48, 60, 69, 76, 78*). The values quoted about composition of the fruits and nuts were drawn from a variety of sources but mainly from the publications by Watt and Merrill (*72*), Woot-Tsuen, Pecot, and Watt (*80*), and Miller and Branthoover (*43*).

CLIMATIC AND SOIL VARIATIONS WITHIN THE TROPICS

Climate

Although some tropical areas exhibit little change in temperature from season to season, great variations in climate do occur. Lee (*38*) points out that infinite variety is possible in the details of climate. One of the most important factors affecting climate is temperature as influenced by elevation. All the world over, the mean annual temperature decreases with increase of altitude at approximately 1° F. for each 330 feet of elevation (*34*). Some areas on the equator lie at such high elevations that temperate fruits such as apples, pears, and peaches can be grown successfully. Conversely, these regions are unsuited for culture of the fruits commonly thought of as being grown along the equator.

Rainfall also is a very important factor influencing the kinds and types of plants that can be grown (*16*). Total annual precipitation in Puerto Rico, for example, ranges from less than 15 to more than 200 inches. Furthermore, great variations occur in the seasonal distribution and intensity of precipitation. Some areas have rainfall fairly evenly distributed throughout the year, whereas other areas experience one or more very dry and very wet periods annually. Such extremes point out the necessity for providing adquate soil drainage and facilities for irrigation. Both procedures may be necessary during the year. Other deleterious factors also may be associated with excessive rainfall. In areas of very high precipitation, the amount of sunlight reaching the plants may be drastically reduced and thereby preclude culture of certain fruit and nut species. The high relative humidities associated with high rainfall may have a direct detrimental effect on flowering and fruit set owing to the greater prevalence of disease organisms.

Certain locations may be exposed to continuous winds of rather high velocity, which also may limit fruit culture. High winds tend to damage foliage and fruit by the whipping action of the limbs, and, if continuous, may cause malformations of the plant. If the site of the fruit plantation is close to the ocean, such winds often carry large amounts of salt, which adversely affect growth when deposited on the leaves. A few species, however, are tolerant of salt spray. The Natal plum is one which can be recommended for culture under such conditions.

Soils

Tropical soils are variable in texture, structure, organic-matter content, and in content of the mineral elements essential for plant

growth. Texture is defined as the amount of gravel, sand, clay, organic matter, and so forth that make up a particular soil. The structure of a soil is the result of the grouping of these individual particles into units or aggregates, and is profoundly affected by the organic-matter content. Alexander (4) states that * * * "the organic-matter content is an index to the physical condition of the soil in the same way that body temperature is an index to the condition of a patient." Adequate amounts of organic matter increase soil aggregation and improve soil structure, two very important considerations in the cultivation of all plants. Soils of good tilth are easy to cultivate, provide good water drainage and aeration, and will support abundant plant growth.

Soil factors such as stones, bedrock, hardpans, claypans, sand and gravel strata, and sod mats also have definite, usually harmful, effects on the growth of plants.

The relative alkalinity or acidity of a soil is important in determining the types of plants that can be grown. Most plants grow best in soils ranging from slightly acid (pH 5) to neutral (pH 7). The tropical fruits and nuts that grow well in very acid soils are mentioned in the individual descriptions. Soils that are too acid for plant growth often can be fitted for culture by the application of limestone or lime.

The soil serves not only as a support for plants and as a source of certain essential elements but also as a reservoir from which water is drawn by the plant. Water makes up a great part of the fresh weight of plants and is the carrier through which mineral elements are absorbed by the plant. If natural rainfall fails to supply the moisture necessary to support plant growth, supplemental water must be applied to the soil. Obviously, rigid rules as to the frequency of watering cannot be prescribed.

Enough water should be applied to keep the plants turgid and growing satisfactorily. Most fruit and nut plants die if subjected to flooded conditions for more than a few days. Since roots are living matter, soil aeration is necessary to maintain an adequate supply of oxygen for respiration. Excessive moisture can be removed by ditches or by drainage tiles placed in the soil. Thus, in many areas of the Tropics, moisture supply is a twofold problem —water must be applied during dry seasons and excess water must be removed during wet seasons.

It should be recognized also that soil is not an inert system, but contains many micro- and macro-organisms, which are influenced by cultural practices, and which, in turn, affect in many ways the plants being cultivated.

The present condition of a soil being considered as a site for a tropical or subtropical fruit or nut planting will have been influenced by the parent material from which it was derived, climatic conditions, types of plants that have grown in it and, of course, by the cultivation practices followed in the crops previously grown. Thus, the proper selection of site in relation to the soil and climatic requirements of the particular plant to be grown is essential to the successful cultivation of the fruits and nuts described in this publication.

OBTAINING AND PROPAGATING THE PLANTS

It is best to obtain the desired fruit and nut plants from a commercial nurseryman whenever possible. Such plants can be certified as to species and variety and should grow well when transplanted. In many areas of the Tropics such a service is not available, however, and thus it becomes necessary to propagate the plants using one, or sometimes both, of the following general procedures: Sexual propagation (seeds), or asexual propagation (grafts, cuttings, and layers). Brief descriptions of the most commonly used procedures follow, but many excellent books and articles are available for those interested in detailed discussions (*2, 20, 40, 71, 74*).

Sexual Propagation

Many of the fruit plants discussed in this publication can be propagated by seeds. Most seedlings, however, do not produce plants exactly like the parent and generally are disappointing when they finally mature and produce fruit. Seedlings are grown as a source of rootstock material onto which named varieties or outstanding selections can be grafted.

It is desirable to use seed from well-formed, vigorous trees of local origin that have produced fruit with desirable horticultural characteristics. Mature fruits should be collected and the fruit pulp cleaned carefully from the seeds. The seeds of many tropical plants germinate whenever conditions are favorable and can be planted immediately after removal from the fruit.

The best results usually are obtained by planting the seeds in shallow boxes filled with a mixture of equal parts of sand, topsoil, and organic matter, or with sphagnum moss. The flats should be watered and, after germination, the seedlings should be shaded lightly and protected from excessive rainfall. After the seedlings reach a desirable size, they can be transplanted to a nursery bed for an additional year or two of growth, or to their permanent location.

Asexual Propagation

Asexual propagation is achieved by taking some vegetative portion of the plant and placing it on a suitable rootstock or by inducing the vegetative portion to produce roots. This type of propagation is used to perpetuate a variety that would not reproduce true from seed. It is obviously necessary to use this procedure to reproduce the types such as breadfruit, which bear seedless fruits. Some plant species naturally reproduce by asexual means. The runner plants of strawberry and pinguin, and the suckers from roots of raspberries, *Flacourtia rukam,* and *Phyllanthus emblica* are common examples of this.

Graftage

This is the technique in which a portion such as a bud or twig (scion) of one plant is placed onto another plant (root-stock) in such a manner that union of the two takes place. When a twig is used the process is termed grafting, and when a bud is

used the process is commonly referred to as budding. Many methods of grafting and budding have been developed, but in all the critical factor is that the cambium tissues of the two parts must be in close contact if union is to take place.

All plants cannot be grafted one upon the other. In general, plants of the same botanical genus can be grafted on each other, and in some cases, plants belonging to the same botanical family can be intergrafted. The relationships are shown in the List of Plants by Botanical Family. For the best and most consistent results, however, it is best to graft onto a seedling plant of the same species of fruit or nut.

Budding.—A vegetative bud from a desired variety is removed with a small amount of the wood and cambium tissue attached. The leaf is cut off leaving about 0.5 inch of petiole, so that the bud can be handled easily. This bud then is placed into a small T-shaped cut a few inches above the ground on a seedling 3 to 6 feet in height. The bud is wrapped with raffia, waxed tape, or rubber budding strips. Within a few weeks the tissues of the bud will have united with those of the stock plant, and the wrapping material should be removed to prevent constriction. After the bud has started growth, the portion of the seedling tree above the bud is removed. This forces the bud into rapid vegetative growth, which eventually forms the entire upper portion of the plant. Any growth that develops on the seedling tree below the point where the bud is inserted should be removed so that the desired variety is maintained.

Grafting.—The technique of grafting usually is utilized for changing an existing tree to a different variety, rather than as a method of large-scale propagation. Many procedures have been developed but cleft, bark, and whip grafting are most commonly used. For cleft grafting, a scion is prepared by cutting a 6- to 8-inch length of 1-year-old wood about 0.25 to 0.5 inch in diameter. Two sloping cuts are made on the base of the scion. The stock is prepared by making a straight cut across a branch 2 to 3 inches in diameter and then making a split across the center. The split is held open with a wedge and one scion is placed on each side of the branch stub so that the cambiums of the scion and stock are in contact. The wedge is removed and the springiness of the stock holds the two scions in place.

Bark grafting is accomplished by cutting a 2- to 3-inch branch at right angles and removing several strips of bark down to the cambium. Scions are cut only on one side at the base and then are placed against the cambium of the stock. The scions are nailed in place with several small brads.

The exposed surfaces of both cleft and bark grafts should be covered with grafting wax to prevent disease organisms from entering.

Whip grafts are seldom used on material larger than about the diameter of a pencil. Both stock and scion are made with a sloping cut, then each one is slit between the center and the tip of the cut. The two tongues thus formed are forced together. If the stock and scion are not the same diameter, the cambium layers on one side should be matched. The completed graft is wrapped with cord

or tape and, if aboveground and exposed to the air, should be covered with wax.

Cuttage

Many plants can be propagated by taking a piece of the mother plant and placing it under conditions favorable for root development.

Cuttings are made from roots, stems, or leaves. Stem cuttings are of two types, depending on maturity of the tissue: Softwood cuttings made from immature parts of the plants, and hardwood cuttings made from mature, usually dormant, growths.

The roots of certain plants such as the mulberry, guava, red raspberry, and breadfruit have the capacity of developing vegetative growth from the roots. These plants can be propagated by using root pieces about 6 inches long and the diameter of a pencil. These are placed in sand and kept well watered until adequate new roots and a stem have been produced. These plants then can be transplanted to a nursery for further growth or, if of sufficient size, can be placed directly in their permanent location.

Stem cuttings should be cut into lengths of 8 to 12 inches, the lower leaves removed, and the base of the cuttings placed in a propagating bed filled with sand. Sacking or palm leaves should be placed over the bed to provide shade, and the cuttings should be well watered. Since such cuttings do not have roots when planted, it is necessary to keep the soil moisture content high to prevent wilting of the leaves owing to excessive loss of moisture by transpiration.

Cuttings of many species root more readily and profusely if they are treated with root-promoting hormone chemicals. Many such preparations are available either as liquid or powders. The directions for use on the label should be followed carefully.

Marcottage

This technique, also known as air layering or Chinese air layering, is used to induce root formation on an aboveground part still attached to the parent plant. A 1-inch ring of bark is removed from a terminal growth 0.25 to 0.5 inch in diameter. The stem over the cut is covered with a handful of moist sphagnum moss, which in turn is covered tightly with clear plastic such as polyethylene. The plastic prevents evaporation of moisture from the moss but permits free exchange of gasses essential for tissue growth.

When roots can be seen through the plastic, the branch is cut off and planted in a nursery bed until sufficiently strong for transplanting to its permanent location. Air layering is a suitable method for obtaining a few plants of a particularly desirable variety, but is uneconomical if a large number is required. This method is commonly used to propagate the breadfruit and the velvet apple.

Layerage

This method of vegetative propagation consists of bending an aboveground part of the plant so that it is covered with soil. The portion is severed from the parent plant after a root system has developed. Many fruit and nut species can be propagated in this manner, but most are too tall for the branches to be bent to the ground readily. Some plants, such as the Ceylon raspberry, can be propagated readily by a modification of this procedure, known as tip layering. This is accomplished by bending mature canes so that the tip is in contact with the ground and then covering it with soil. New shoots are produced from the tip after roots have been formed.

Division

This procedure, which is applicable to only a few of the plants described in this publication, consists of dividing the mother plant into several parts, each of which will develop into a new plant. Strawberry plants that fail to produce runners can be increased by dividing the crown into a number of parts. The crown should be cut with a sharp knife; each portion must have a new growing point and some roots. The pinguin typically is propagated by separating runner plants from the parent. Shrubs and vines that have more than one stem arising from the crown or base also can be propagated in this manner. The stems should be cut back after division to reduce excessive loss of moisture through the leaves. Such propagules should be placed under shade and watered carefully until new growth is established.

CULTURE

Planting

Seedling trees frequently can be grown directly in their permanent location, but it is wise to take the precaution of planting several seeds at each desired location. Several months after germination the weakest seedlings should be removed, leaving only the straightest and most vigorous one. The better types of most fruit and nut species will have been propagated asexually in a nursery bed and must be transplanted to their permanent location. Most tropical fruits are evergreen and, hence, are not dormant at the time of transplanting. The plants should be excavated with a large ball of earth so that as much as possible of the root system is retained.

The holes that are to receive the roots should be dug large enough to accommodate the natural spread of the roots and deep enough so that the plants are a little deeper than they stood in the nursery. Most soils benefit by the liberal application of organic matter. In many areas of the Tropics, filter-press cake waste (commonly called "cachaza" in the Latin American countries) from sugar mills is an excellent and readily procurable source of organic matter. This material is a good soil conditioner but supplies little in the way of elements essential for plant growth

and should be supplemented with applications of inorganic fertilizers.

Since part of the root system will be lost in digging, the newly transplanted fruit plant should be partly defoliated or pruned back slightly. This reduces the evaporating surface of the tree until enough new feeder roots are formed to take up adequate water for the plant.

Mulching the soil around the plant aids in soil moisture retention and helps control weeds. Many materials, such as straw and grass clippings, can be used as a mulch. One precaution should be kept in mind—the cellulose of the mulch is broken down by bacteria, and nitrogen is used in the process. Although this nitrogen is eventually returned to the soil, the immediate effect may be a tendency toward deficiency of this essential element. If strawy mulch is used, a light application of nitrogen fertilizer should be made prior to applying the mulch.

Fertilization

Some soils are deficient in one or more of the elements essential for plant growth. In addition, some of the elements may be in the soil but in chemical combinations not readily available to plants. Elements lacking or unavailable must be applied to the soil or to the plants as foliar sprays if adequate plant growth is to be achieved. Specific fertilizer recommendations cannot be given because of the great variation in tropical soils, but nitrogen and possibly potassium are the elements most likely to be limiting for fruit and nut plants.

Element deficiencies tend to cause fairly characteristic symptoms, which are an aid in prescribing fertilizer treatments. An example is the yellowing of foliage that occurs when nitrogen is deficient. Although it does not deal with tropical fruits, the text Hunger Signs in Crops (*28*) would be a useful guide when expert assistance is not available.

Animal manures should be used whenever available. They contain many of the mineral elements essential for plant growth and are high in organic matter which is necessary to maintain and improve soil structure. Manure should be well rotted before it is incorporated into the soil around the fruit plant. In many cases, sufficient quantities of animal manures will not be available, and it becomes necessary to use commercial, inorganic fertilizers. These usually contain nitrogen, phosphorous, and potassium in amounts as shown on the label. Fertilizers of many different analyses are available and, in addition, the separate carriers can be purchased if desired.

The fertilizer applied should be incorporated into the soil, so that it will be readily available to the feeder roots of the plants and so that it will not be carried away by surface water movements. In general, small amounts of fertilizer applied several times during the year give a more efficient use and a better plant response than the same amount placed in one application only.

Pruning

Pruning of most plants is still an art rather than a science, but all pruning is undertaken to achieve one or more of the following objectives:

(1) To modify the shape or habit of the plant in order to facilitate cultivation, spraying, and harvesting the crop.
(2) To influence the size, quality, and quantity of fruit.
(3) To remove, renew, and promote or retard growth of parts of the plant.

Little is known about the proper pruning practices for most tropical fruits. It is known, however, that tropical fruit plants generally require little pruning in comparison to temperate fruit plants. The pruning of tropical fruits usually is confined to training in the first few years to develop proper shape and, in later years, a light, thinning-out process to prevent crowding in the crown of the plant. Weak and diseased branches should be removed and either burned or buried. The actual amount of pruning depends on the growth of the tree and on the shape desired. Light annual pruning to prevent crowding aids the tree in producing larger and higher quality fruits and still maintains a form suitable for ornamental purposes. Heavy pruning should be avoided, since it tends to dwarf trees and may adversely affect flower bud production.

The dormant season is considered the best time to prune fruit trees. Some tropical fruit and nut trees lose their foliage and become dormant during the dry season or during the cool months of the year. The tropical almond loses its foliage during the dry season and should be pruned at that period. Evergreen plants, which do not become dormant, should be pruned during the dry season or at other times of the year when the plants are not in a new flush of growth.

Pollination and Fruit Set

Pollination is defined as the transfer of pollen grains from the male element (stamen) of a flower to the stigma or tip of the female part (pistil). Subsequently, the pollen grain germinates, sending out a long pollen tube. This tube grows down the style of the ovary, reaching and penetrating the embryo sac. There fertilization takes place and the fruit begins to develop. Most of the fruit and nut species described in this publication require pollination in order to develop a crop. A few fruits, such as some varieties of figs, do not require pollination and fertilization. Such fruits are seedless and are known as parthenocarpic fruits. The edible part of nuts is the seed, however; so fertilization is particularly important for all nut crops.

Most fruit plants produce perfect flowers, containing both male and female parts. In some plants, however, the male and female flowers are borne on separate parts of the same tree (monoecious) or, as in the Ceylon gooseberry, on separate trees (dioecious). In the latter case, it is necessary to plant trees of both types or to have the two types of flowers grafted onto the same plant. The trees having only male flowers never bear fruit but do produce

pollen, which can be transferred to the female flowers and effect fruit set.

The pollen of most fruit plants is transferred from the male to the female flower parts by insects, although wind is operative in the case of some nut species. The insects most important in pollen transfer are honeybees, but other insects are important for a few plant species. Carpenter bees, for example, are reported to be the most effective agents in pollen transfer of the passion fruits.

Pest Control [3]

Pest control is important in the successful management of a home or commercial fruit planting. Many pests attack fruit and nut plants in the Tropics, and the development of adequate control measures is complicated by the year-round growing conditions that prevail. Yet it is folly to have the work and expense of propagating and planting nullified by failure to control insects, diseases, and other pests.

The main pests that attack fruits and nuts in the Tropics are insects and diseases. Other, usually less serious, pests include nematodes, snails, slugs, and animals such as bats and rats.

Many species of destructive insects occur in the Tropics. Their presence usually can be detected readily by the appearance of the foliage and sting marks on the fruits. Based on their feeding habits, insects can be divided into two main groups: Chewing insects, such as many beetles and caterpillars; and sucking insects, such as aphids, scale insects, and thrips. Chewing insects are controlled by stomach poisons, which must be applied where the insects will consume them as they feed on the foliage or other plant parts. Lead arsenate, calcium arsenate, and rotenone are commonly used stomach poison insecticides.

The second broad group of insects obtain their food by piercing or rasping the surface of the plant and sucking out the plant sap. Since they are unaffected by stomach poisons, they are controlled by insecticides applied directly on the insects or on a plant surface that the insect will contact. Widely used chemicals of this type are nicotine sulphate, pyrethrum, rotenone, chlorinated hydrocarbons such as DDT and chlordane, and the phosphatics, parathion and malathion. *Parathion, because of its extreme toxicity to humans, is not recommended for home use.* Many of the contact insecticides have a residual effect and function as stomach poisons.

Diseases affecting fruit and nut plants fall into four groups: Fungus, bacterial, virus, and physiological. Fungi and bacteria probably are responsible for more damage than any other disease agents. Leaf spots, blights, and wilts are examples. Diseases of this sort are most effectively controlled by Bordeaux mixture, fixed copper fungicides, and organic compounds such as Zerlate, Fermate, and Dithane. Several bacteria and fungi enter through the root system, spread internally through the plant, and cause wilting or death of the plant. Sprays are ineffective against these internal diseases, but it is recommended that resistant varieties be used and that they be planted in disease-free soil.

[3] Mention in this section of any product by trade name is not to be construed as endorsement by the United States Department of Agriculture over other similar products not mentioned.

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Virus diseases occur on a few of the fruits and nuts described in this publication. They can be recognized by light- and dark-green mottling of the foliage; and by twisting and stunting of the leaves, especially on the terminal growth of the plant. The best means of virus-disease control is to use resistant varieties. Plants that show symptoms of virus infection should be removed and burned.

Physiological disorders commonly are classified as diseases but actually are brought about by unfavorable climatic conditions or improper management practices, such as excessive irrigation, drought, lack of proper drainage, and improper or excessive use of fertilizer.

Nematodes are microscopic worms that occur in great numbers in some soils. The parasitic types feed on roots. Their feeding decreases tree vigor and the yield and size of fruit, but usually does not cause death of the plant. In addition to direct damage, open lesions made by nematodes may provide points of entry for soil-borne disease organisms, which damage and may cause death of the plant. Soil fumigation prior to planting and re-treatment with materials such as DD (a chlorinated propane-propylene mixture) and EDB (ethylene dibromide) have been shown to be helpful, but it is best to avoid planting susceptible fruit and nut species in soil known to be infested with nematodes.

Snail and slug damage can be reduced by hand picking, but the best remedy is to use a poison bait containing metaldehyde. Snail baits are available commercially, but a homemade bait can be prepared using the following procedure described by Essig and Hoskins (*24*):

Dry wheat bran	1 pound
Blackstrap molasses	2 tablespoonfuls
Calcium arsenate	1 ounce
Metaldehyde	½ ounce
Water	1 pint

The dry materials are mixed thoroughly; then the water and molasses are added. The bait, which should be mixed only as needed, is applied in small pellets to the ground around the plants to be protected.

Damage to maturing fruits by bats and rats can be prevented by covering individual fruits with wirescreen. Further protection from rats can be secured by trapping and by the placement of baits mixed with poisons such as Warfarin. A common practice on members of the palm family, such as *Aiphanes minima*, is to fasten a 12-inch band of metal around the trunk. Care should be taken with other tree species, however, as they increase in trunk diameter with increasing age, and constriction and death may result.

Pest control is not accomplished only by the application of chemicals. Fruit plants kept vigorous and healthy by proper management procedures such as fertilization and irrigation can resist the attack of many pests. Sanitation also is an important aspect of adequate pest control. Fallen fruits, leaves, and limbs are a source of continued disease infection and insect infestation. Such dropped and decayed material should be collected at frequent intervals and destroyed by burning or burying. Light pruning to permit entry of sunlight and adequate air movement often is

helpful in reducing disease infections. This procedure also aids in more uniform penetration and coverage of spray and dust chemicals when pesticides must be applied.

The natural enemies of insect pests should be encouraged and protected as much as possible. This procedure, known as biological control, often is very effective in protecting fruit plants from serious damage.

Good cultural practices, sanitation, and biological control will, in many cases, reduce to a minimum the necessity of applying chemical pesticides.

A complete description of the materials, equipment, and techniques for applying pesticides would require too much space in this publication. For details the reader is referred to two publications (*15, 16*). The following general considerations, however, should be kept in mind when pesticidal materials are applied to fruit plants:

1. Select the proper material. Application of a fungicide will be completely ineffective in controlling insects.
2. Use the proper concentration. Too low a concentration may not effect control and too high a concentration may result in damage to the plant and increased health hazard to the operator applying the material.
3. Correctly time the application. To be effective, most chemicals should be applied just before the pest becomes active. Thus, even the best materials applied at the wrong time fail to produce satisfactory results.
4. Properly apply the material. Thorough and complete coverage of the plant is essential for successful insect and disease control.
5. Use adequate safety precautions. Many pesticides are hazardous to the person who applies them, and some may leave toxic residues that are dangerous to the consumer. Special precautions, therefore, should be taken in their use. *Follow carefully the directions given on the label,* including taking adequate measures to protect the individual through the use of respirators and protective clothing. Toxic residues often can be avoided by not applying pesticides near the time of harvest. If the label is not specific, obtain expert advice before attempting their use. Assistance in diagnosing pest problems and in devising suitable control measures can be obtained from local agricultural experiment stations and from individuals who have had experience in growing the particular fruit or nut plant.

Pest control materials can be applied in the form of either a dust or a liquid. Spray application of pesticides generally is more satisfactory than dust application and is recommended for most of the fruits and nuts described in this publication. Diseases and insects on some of the low-growing species such as strawberries, however, can be controlled very efficiently by dusting. Both sprayers and dusters are manufactured in many sizes and capacities, so that it is possible to purchase the proper equipment for the kind and the size of plants grown.

NAMING THE PLANTS

The descriptions of the plants in this publication are listed alphabetically according to the most commonly accepted scientific name. Synonyms in common usage or that occur in recent literature also are listed. The English common names are those given in several sources (*9, 10, 12, 33*). The Spanish common names, which are set off with quotation marks, are principally those used in Puerto Rico as listed by Otero, Toro, and Otero (*56*). The family name is given last in Roman type. All these names are listed in the index and, in addition, an alphabetical index of the plants by botanical family is given.

Each description gives the origin and present distribution of the plant, insofar as it is known. The size and appearance of the plant, the leaves, the flowers, and the fruits are given, together with the method of propagation and a synopsis of the cultural information available. The methods of utilizing the fruits and nuts are discussed, and pertinent nutritive values are listed.

DESCRIPTION OF THE PLANTS

Achras zapota L.
(Syn. *Sapota achras* Mill.)
Sapodilla (fig. 1)
"Níspero"
Sapotaceae

The Sapodilla, a very common tropical American fruit, produces attractive evergreen trees that often reach a height of 60 feet or more. In southern Mexico this species is tapped for its white sap, which contains 25 to 50 percent of chicle, a principal ingredient of chewing gum. The elliptic to obovate leaves are 2 to 5 inches long and 1 to 2 inches wide. The inconspicuous flowers are borne in the leaf axils and are produced over a long season, so that ripe fruit may be found most of the year. Fruits usually are 2 to 4 inches in diameter and vary from globose to ovoid. The thin skin is grayish or rusty brown. The yellowish-brown flesh is tender and of delicious flavor. The hard black seeds vary from none to 10 or 12 and are easily separated from the pulp. Two varieties, Prolific and Russell, have been selected and named from Florida, where additional evaluations of clonal selections are being made (*62*). A recent report from Cuba (*70*) describes a seedless form, now being propagated by grafting.

It has been reported from India that fully mature but firm sapodillas can be stored for about 8 weeks. The best storage conditions were found to be a temperature of 35° to 38° F. and a relative humidity of 85 to 90 percent (*66*).

The sapodilla usually is propagated by seeds, which require 4 to 5 weeks to germinate. It also can be grafted or budded. Fruits of the sapodilla are often attacked by both the Mediterranean and Mexican fruitflies, rendering them unfit for consumption.

Aiphanes minima (Gaertn.) Burret
"Coyor," "Coyore" (figs. 2 and 3)
Palmaceae

This medium-sized palm from tropical America is often planted as an ornamental; the fruits are sometimes used for food. It

FIGURE 1.—The sapodilla, *Achras zapota*.

bears long, sharp, black spines on the trunk, leaves, and stems of the inflorescences. The leaves are pinnate, 5 to 8 feet long, and are composed of closely spaced leaflets 8 to 15 inches long and 2 to 3 inches wide. The branched inflorescence, which is borne among the leaves, is 2 to 3 feet long. It bears many orange-red globose fruits each slightly less than 1 inch in diameter.

The thin, fleshy exterior of the fruit is edible and has a sweet,

FIGURE 2.—A 20-foot tall plant of the *Aiphanes minima* palm.

fruity flavor. Inside the hard shell of the single seed is a comparatively thick layer of white meat. In flavor and texture this meat resembles coconut meat, and it may be used in the same way.

Propagation is by seeds.

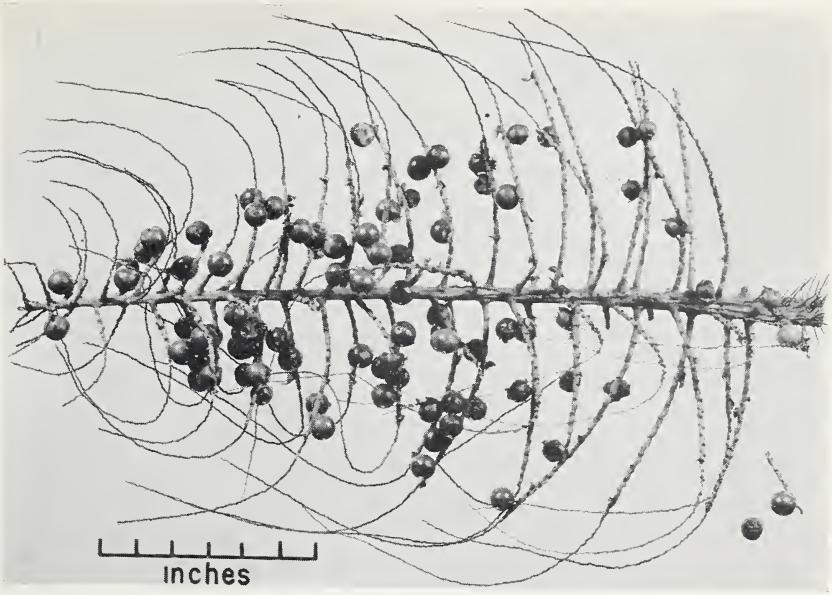

FIGURE 3.—Fruiting inflorescence of *Aiphanes minima*.

***Anacardium occidentale* L.**
Cashew (fig. 4)
"Pajuil," "Marañón"
Anacardiaceae

The Cashew, a native of Brazil, is now found throughout the tropical regions of the world, particularly in India. The tree grows rapidly, reaches a height of 20 to 40 feet, and may bear in 2 years from seed. The leathery, alternate, obovate leaves are 5 to 7 inches long and are prominently veined. The small, fragrant, pinkish flowers are produced in terminal panicles in March and April. The fruit is unusual in that the kidney-shaped nut, the true fruit, is borne on a greatly enlarged, fleshy receptacle. This structure, the cashew apple, is about 2 inches in diameter and 3 to 4 inches in length. At maturity, approximately 3 months after flowering, the fruit turns bright yellow or red. The acid, aromatic juice is used to make wine and jelly. It also can be used to make a refreshing drink and is reported to be an excellent source of vitamin C. The tree, however, usually is grown for the edible nut. The shell contains an oil that is highly irritating to the skin, and the nuts should be heated to render the oil less caustic before the kernels are extracted. Since the caustic oil is expelled from the shell during roasting, do not allow the smoke to come in contact with the eyes or skin. The cashew is one of the most delicious of nuts after being roasted and is rich in protein and fat. The oil, contained in a spongy layer of the shell, has become of great commercial value.

Most trees of this species, including those in India which produce most of the cashew nuts of commerce, have been propagated by seeds. It has been reported, however, that select forms can be

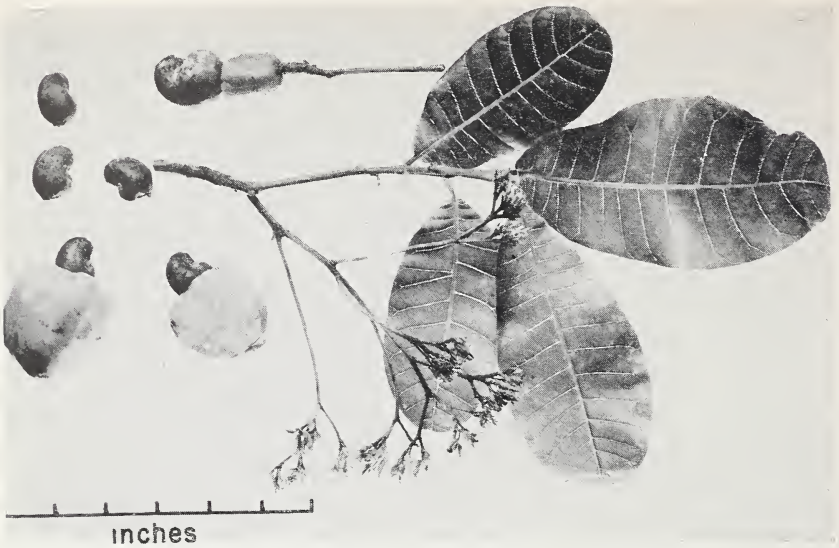

FIGURE 4.—The cashew, *Anacardium occidentale.*

propagated by budding and marcotting. The cashew grows well on a wide range of soil types and is tolerant of drought.

***Annona cherimola* Mill.**
Cherimoya (fig. 5)
"Chirimoya"
Annonaceae

The genus *Annona* comprises more than 50 species of trees and shrubs; with few exceptions, they are native to tropical America. A number of species produce edible fruits, which are composed of numerous carpels more or less fused to the fleshy receptacle. The annonas exhibit great variation in climatic and soil requirements as well as in quality of fruit, which suggests that improved types could be developed readily by controlled crosses and by selection. The Atemoya, a cross between the cherimoya and the sugar apple, has proved satisfactory for southern Florida.

The Cherimoya, native to the mountain valleys of Peru and Ecuador, was early introduced into Mexico and Central America. It is a small, somewhat spreading tree, rarely more than 25 feet in height, and normally begins to produce fruit when 4 to 5 years of age. The leaves vary in size; in some varieties they reach a length of 10 inches. The upper surface of the leaves is sparsely hairy and the lower surface is velvety-tomentose. The inch-long, perfect flowers are produced in the axils of the leaves. The fruits vary in form but usually are heart-shaped or conical. The light-green surface of the fruit is variable in appearance. In some varieties it is almost smooth with slight depressions (termed "fingerprinted"), but in others the carpels are terminated by an abrupt point. The flesh is creamy white and has many dark-brown seeds imbedded in it. It has a custardlike consistency and a subacid flavor suggestive of a blend of banana and pineapple. From the standpoint of quality, it is the best fruit of the genus

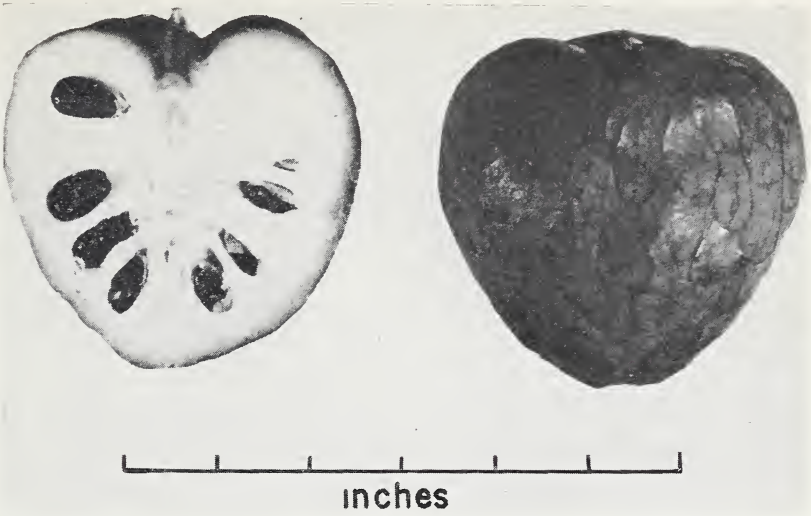

FIGURE 5.—Fruit of the Chaffey variety of cherimoya, *Annona cherimola*. (Courtesy of C. A. Schroeder.)

and is one of the finest tropical fruits. By some it is considered to be equal to, or even superior to, the mangosteen. Cherimoya fruits reach a large size, often weighing 4 to 6 pounds.

It has been reported from California that the male and female parts of the flower frequently do not mature at the same time (*65*). Therefore, cross-pollination of the flowers on the same tree or of different trees is necessary. This can be accomplished readily by transferring mature pollen to the receptive stigma of a freshly opened flower with a camel's-hair brush. Studies in Peru have indicated that hand-pollinated fruits are larger and less irregular in shape than those pollinated by natural means (*57*).

Many varieties of cherimoya have been named, including Bays, Chaffey (fig. 5), McPherson, and Whaley. They are propagated by budding or grafting on vigorous seedlings of the same species. Seedlings of the custard apple and of the sweetsop also can be used as rootstocks.

The cherimoya is essentially a subtropical fruit and has not grown well in the coastal area near Mayaguez, where the trees bear only a few fruits of very poor quality. It can, however, be grown under the conditions of lower temperatures that prevail in the mountainous regions.

The Ilama (*Annona diversifolia* Saff.) produces fruit similar to that of the cherimoya. The foliage is similar to that of the sweetsop but can be distinguished from the latter by the leaflike bracts at the bases of the smaller branchlets. The conical or ovid fruits vary from types having a smooth surface to those having carpels with short, thick protuberances. The skin color varies from light green to pinkish. The white or pinkish flesh has a subacid to sweet flavor. Although resembling the cherimoya in fruit shape and taste, the ilama grows well in the lowlands of the Tropics.

It is commonly propagated by seeds, but has been successfully veneer grafted (*54*).

Annona muricata L.
Soursop (fig. 6)
"Guanábana"
Annonaceae

The Soursop is a small evergreen tree that usually does not grow taller than about 20 feet. The shiny, leathery leaves are 4 to 6 inches in length, obovate to oblong, and have a distinctive pungent odor when crushed. The large flowers are produced on short stems on the branches and, often, directly on the trunk of the tree. The exterior, cream-colored petals of the flower are thick and fleshy. Hand-pollination greatly improves fruit set, as the stigma of each flower is not receptive until after the pollen has been shed.

The large dark-green fruits are often irregular in shape but most frequently are ovoid or oblong-conical. The surface of the fruit is covered with numerous, recurved fleshy spines. The flesh is white, slightly subacid, and has a distinctive, pleasant taste. Fruiting is continuous throughout the year, the main crop being produced between June and November. The pulp is sometimes eaten as a dessert fruit after adding a little sugar. It is more commonly used to make a refreshing drink and for flavoring sherbets and ice creams. Jelly and preserves also can be made from the pulp. Care should be taken to remove the unpleasant-tasting skin when the fruit is prepared for consumption. The pulp is a good source of vitamins B and C, and of the mineral phosphorus.

The soursop can be propagated readily from seeds and by budding. It is the most tropical of the annonas.

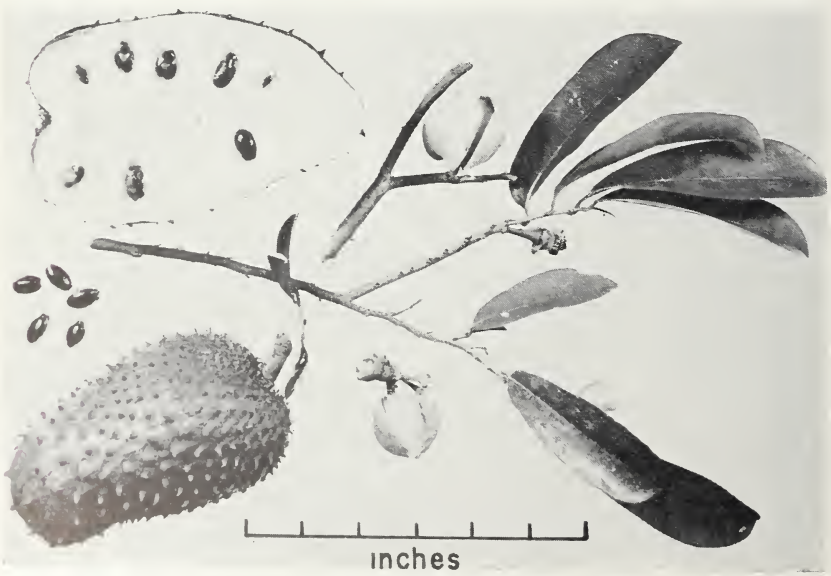

FIGURE 6.—The soursop, *Annona muricata.*

The Mountain Soursop (*Annona montana* Macfad.), also is grown to a limited extent. It resembles the soursop tree in growth, but the leaf is larger. The fruit (fig. 7) is nearly spherical, and the yellowish skin is sparsely covered with short prickles. The yellowish pulp is similar to the soursop in flavor but is inferior to that fruit. Variations among seedling trees indicate that higher quality strains might be selected. The mountain soursop grows well on dry soils and may have merit as a rootstock for other annonas.

FIGURE 7.—The mountain soursop, *Annona montana*.

***Annona reticulata* L.**
Custard Apple, Bullock's Heart (fig. 8)
"Corazón"
Annonaceae

The Custard Apple, native to tropical America, is a deciduous tree 20 to 25 feet in height. The oblong to lanceolate leaves are up to 10 inches in length and are pubescent when young but smooth when mature. The flowers are produced in the axils of the leaves on the new growth. The globose-ovoid fruits are 3 to 5 inches in diameter. The skin is smooth, but the surface is faintly

FIGURE 8.—The custard apple, *Annona reticulata.*

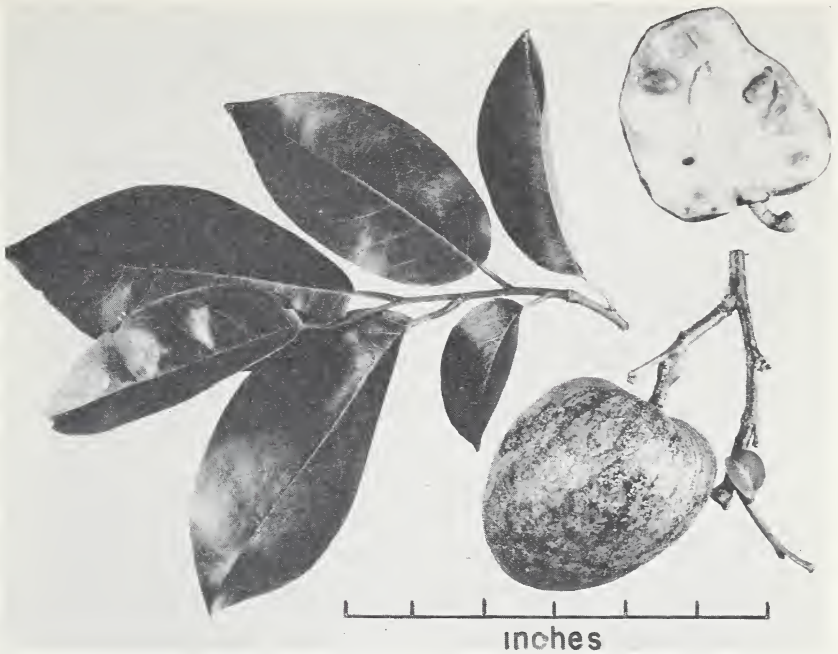

FIGURE 9.—Foliage and fruit of the pond apple, *Annona glabra.*

divided into platelets showing that, botanically, the fruit has resulted from the fusion of many carpels. The skin is brownish when ripe and may be blushed with red on one cheek. The pulp of the fruit is off-white and is sweet but tends to be somewhat insipid. The custard apple is one of the poorest of the annonas with respect to quality. This fruit is often confused with the Pond Apple, *Annona glabra* L., because of the similarity in fruit shape (fig. 9). The orange-colored pulp of the pond apple is inedible, but the plant does have promise as a rootstock for other annonas because of its tolerance to flooded conditions.

The custard apple can be propagated readily from seeds; the seedlings begin producing fruit when 4 to 5 years of age. It also can be grafted or budded on seedlings of the same species, or on those of soursop, sweetsop, and pond apple. Trees of the custard apple grow well on a wide range of soil types and are better adapted to the drier regions of the Tropics than are the other annonas. They cannot tolerate excessive soil moisture.

Annona squamosa L.
Sweetsop, Sugar Apple (fig. 10)
"Anón"
Annonaceae

The Sweetsop is a small deciduous tree that rarely reaches a height of more than 20 feet. The 8- to 10-inch leaves are usually lanceolate to oblong-lanceolate. This species probably is indigenous to the warmest part of Central America and grows best in the warm dry areas of the Tropics. The fruit, which ripens in

FIGURE 10.—The sweetsop, *Annona squamosa.*

the spring, is subglobose or ovoid. It is composed of loosely cohering carpels which are usually covered with a white or bluish bloom. The carpels separate readily when ripe, exposing the cream-colored flesh in which are imbedded numerous small, brown, glossy seeds. The fruit pulp has a custardlike consistency and is

sweet and pleasant tasting. The pulp usually is eaten fresh as a dessert fruit, but it is also used to make a delicious sherbet. The sweetsop is of better quality than the custard apple and deserves to be more widely planted in the Tropics. If allowed to ripen fully on the tree the fruits split open. Such losses can be prevented by picking the fruits before they reach this stage and allowing them to ripen off the tree.

As with the other annonas, the sweetsop often is grown from seeds. Such seedlings usually come into bearing when 3 to 4 years of age. Improved selections can be propagated readily by grafting or budding.

Antidesma bunius (L.) Spreng.
Bignay (fig. 11)
Euphorbiaceae

The Bignay is a medium-sized evergreen tree native to Malay-Asia. The dark-green and glossy, alternate leaves make the tree an attractive ornamental. The leaves usually are elliptical but are sometimes obovate and measure 4 to 6 inches in length by 2 to 3 inches in width. The small petalless flowers are produced on terminal or axillary inflorescences. The flowers have an offensive odor which, however, is not noticeable a short distance from the plant. Male and female flowers are borne on separate trees, but isolated female trees usually fruit abundantly. Limited tests have shown that the seeds from such fruits do not germinate. Pollination and fertilization, therefore, apparently are necessary to produce viable seed. The globose or ovoid fruits are about 0.5 inch in diameter and turn a dark purplish-red when mature. Each fruit contains a single seed imbedded in a juicy, purplish-red pulp. The acid-flavored pulp is not suited for eating out of hand but can be used to make excellent jam or jelly, and a good wine. The fruits are produced in clusters of 20 to 30, but all do not ripen at the same time. The main fruiting season is July through September. The juice stains the fingers and clothing. The fruits are great favorites of birds, which often destroy part of the crop.

The bignay is usually propagated by seeds, but budding has been successfully employed. In Java, the tree also has been propagated by cuttings and by marcotts. It grows well on a wide range of soil types.

Antidesma platyphyllum H. Mann. also is sometimes grown for its edible fruit. It is more upright and forms a larger tree than does the bignay. The pink or light-red fruits are smaller than those of the bignay and are used to make wine, sirup, or jelly.

Artocarpus communis Forst.
Breadfruit (fig. 12)
"Pana," "Panapén"
Moraceae

The Breadfruit is one of the most handsome trees of the Tropics. It is thought to have originated in Malaysia and to have been carried to the South Pacific Islands by the Polynesian migrations. The seedless breadfruit is now grown to some extent in most tropical areas. It was brought to the West Indies in 1792 by a second expedition under Captain Bligh, whose disastrous first voyage in the Bounty created worldwide interest in the plant.

FIGURE 11.—Leaves, fruit, and seed of the bignay, *Antidesma bunius*.

The 30- to 60-foot trees bear luxuriant, dark-green leaves 1 to 3 feet in length and usually divided into several deep-cut lobes. The minute flowers are clustered on separate stems in the axils of newly formed leaves. The club-shaped male inflorescence is 6 to 12 inches long and drops to the ground in a few days. The 2-inch globose green heads, which are the female inflorescences, develop into the seedless fruits. One to three fruits grow together at the tip of each branch. Many varieties are known but the distinguishing characters are not well defined. Wilder (*77*)

FIGURE 12.—The breadfruit, *Artocarpus communis*.

described 31 varieties from Tahiti, some with a few seeds at times.

The mature fruit is roundish or ovoid, 5 to 8 inches long by 4 to 6 inches in diameter, and may weigh from 2 to 10 pounds. The yellowish-green rind is divided into a series of low projections that may bear short spines in some varieties. A large central core is surrounded by numerous abortive ovules. The edible portion is the white or yellowish pulp of slightly immature fruit, which is either boiled as a vegetable or roasted. When roasted it resem-

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FIGURE 13.—The breadnut, *Artocarpus communis.*

bles bread in flavor. The carbohydrate value of breadfruit is high. It is a fair source of thiamine and vitamin C in the cooked state.

The tree grows rapidly and comes into bearing early. The main crop is produced from May to August in the West Indies with some fruiting throughout the year. Fruiting is more prolific in humid areas, but the trees will stand several months of drought each year. Propagation is by suckers from the roots, root cuttings, layering, or marcotts.

The Breadnut, or "Pana de Pepita," (fig. 13) is a prolific seed-bearing variety common in some areas of the Tropics. It closely resembles the seedless breadfruit except that the tree is a little more coarse in character. The rind of the fruit is covered with fleshy spines. Little edible pulp remains in most varieties, as it has been replaced by brownish seeds 1 inch or more in length and up to 1 inch in diameter. The seeds are edible after boiling or roasting and are said to resemble chestnuts. The seeds are a good source of calcium, phosphorus, and niacin.

The breadnut is easily propagated by seeds, which should not be allowed to dry out completely.

FIGURE 14.—Fruit and foliage of the jack fruit, *Artocarpus integra.*

***Artocarpus integra* (Thunb.) Merr.**
Jack Fruit, Jak-Fruit (fig. 14)
"Jaca"
Moraceae

The Jack Fruit, a close relative of the breadfruit, is a very large tree cultivated as a novelty in parts of the West Indies. Its fruits are highly prized in Ceylon and other parts of the Asiatic Tropics. Unlike the breadfruit, the leaves of the jack fruit are usually entire and only about 6 inches long. The fruits are borne on short lateral branches along the main trunk and larger branches during the humid, rainy season. They are oval to oblong and vary in weight, according to the variety, from 10 to 40 pounds. Burkill (*13*) reports that they may occasionally exceed 110 pounds in weight. The green rind is made up of hexagonal fleshy spines.

The pulp of the fruit is eaten raw or cooked, and it is sometimes used as a vegetable in curries. The seeds are enclosed in slippery, juicy coverings that have a strong pungent odor and a sweet or acid flavor. This part is sometimes combined with other fruits in a fruit salad. The large edible seeds are said to resemble chestnuts after boiling or roasting.

Propagation is by seeds, which have a short period of viability. They should be planted in the permanent location as nursery-grown plants are difficult to transplant. Growth is rapid and seedlings may fruit in 3 or 4 years. The trees develop most rapidly in fertile, moist soils.

Several related species produce edible fruits or seeds in the Asiatic Tropics. Perhaps the most important of these is *Artocarpus odoratissima* Blanco, the Marang of the southern Philippines and Borneo. It has larger leaves than the jack fruit and spiny fruits about 6 inches long. The edible pulp and seeds resemble those of the jack fruit. *A. champeden* (Lour.) Spreng. is cultivated in the Malay Peninsula. Both the flesh and the seeds are eaten.

***Averrhoa bilimbi* L.**
Bilimbi, Cucumber Tree (fig. 15)
"Blimbe," "Grosella China"
Oxalidaceae

The Bilimbi is native to the Moluccas (Indonesia) but is now cultivated in many other places in the Tropics. It forms a medium-sized to large tree that may reach a height of 60 feet, but more commonly is 20 to 30 feet. The odd-pinnately compound leaves are large, containing up to 45 leaflets. The oblong-pointed leaflets are 2 to 4 inches in length and have short petiolules. The dark-red flowers are produced in panicles from the trunk and older branches. The mature fruits resemble small cucumbers and usually range from 2 to 3 inches in length. They have a smooth, thin, green rind sometimes faintly five-angled, and an acid pulp in which are imbedded several small seeds. As with the carambola, there is a sweet form of the bilimbi, which lacks the acid taste. Fruits of the bilimbi are candied or cooked with sugar as a preserve. The pulp also is used to make a refreshing drink.

The bilimbi is usually propagated by seeds but improved forms may be marcotted.

FIGURE 15.—The bilimbi or cucumber tree, *Averrhoa bilimbi.*

***Averrhoa carambola* L.**
Carambola (fig. 16)
"Jalea"
Oxalidaceae

The Carambola, native to Indochina, is an attractive ornamental tree that attains a height of 30 to 35 feet. The odd-pinnately compound leaves have 3 to 11 leaflets, which are ovate or ovate-lanceolate. The small, fragrant, rose-colored flowers are produced in cymes from the leaf axils or laterally on the stems. The ovoid to ellipsoid yellow fruits are 4 to 5 inches in length and are acutely 5-angled. The fruits are star-shaped when cut across and are crisp, juicy, and aromatic, although usually acid in taste. One form is called the "sweet carambola" because it lacks the acid taste. The fruits have been reported to contain 50 percent of reducing sugars on a dry-weight basis and to be a good source of vitamins A and C. The ripe fruits are used for preserves, jams, and jellies. The star-shaped cross sections make an attractive addition to salads.

The carambola can be grown successfully on soils ranging from sands to heavy clays and is reported to be drought resistant after it has become well established. Propagation can be accomplished readily with seeds, and budding also has been successfully used.

***Bixa orellana* L.**
Annatto (fig. 17)
"Achiote," "Bija"
Bixaceae

The Annatto is a shrub or small tree native to the West Indies and to South America. The reddish-veined, heart-shaped leaves and the showy flowers borne on terminal panicles give it value as an ornamental. The 3-inch flowers are pink or white and have many stamens. The heart-shaped scarlet fruits turn brown

FIGURE 16.—The carambola, *Averrhoa carambola.*

or reddish-brown at maturity, and are covered with short stiff hairs. When fully mature, the fruits split open exposing the numerous seeds. Although it does not produce an edible fruit, the annatto is widely grown for the orange-red pulp that covers the seeds. The annatto dye, which is prepared by stirring the seeds in water, is used to color butter and cheese. It is also widely used in Latin America to color rice and other foods. In the Philippine Islands the seeds are ground and used as a condiment.

The annatto can be propagated by cuttings of mature wood and by seeds.

FIGURE 17.—The annatto, *Bixa orellana.*

***Blighia sapida* Koen.**
(Syn. *Cupania sapida* Voigt.)
Akee (fig. 18)
"Seso Vegetal"
Sapindaceae

The Akee is native to western tropical Africa and was introduced into Jamaica in the late 18th century. It has spread to other parts of tropical America but is still more widely grown in Jamaica than elsewhere. The tree is medium-sized and evergreen. The odd-pinnately compound leaves have 3 to 5 pairs of dark-green, obovate-oblong leaflets. The small, greenish-white, fragrant flowers are produced laterally in racemes. The trivalved fruits turn yellow and red as they ripen. The mature fruit splits open along 3 sutures exposing the 3 large, shiny, black seeds attached to a white or milky-white aril. The firm and oily aril is the edible portion and is consumed fresh or is cooked and used as a vegetable. Great care must be exercised in using this fruit, since both immature and overmature fruits may be toxic. Two peptides that proved to be toxic to animals have been isolated from unripe seeds of the akee (*30*). One of these, hypoglycin A, also occurs in the edible portion, the concentration being particularly high when the aril is not fully ripe. Only naturally opened fruits should be eaten, and care should be taken to remove the pink or purplish membrane near the seed.

The akee grows satisfactorily on a wide range of soil types but makes best growth on loams well supplied with moisture. It is propagated readily by seeds; the seedlings begin to bear in about 5 years.

FIGURE 18.—Leafy branches and fruit of the akee, *Blighia sapida*.

***Bromelia pinguin* L.**
Pinguin (figs. 19 and 20)
"Maya"
Bromeliaceae

The Pinguin, native to tropical America, produces a compact rosette that may contain as many as 40 leaves. The stiff, linear, long-attenuate leaves are up to 2 inches across and 3 to 6 feet in length. They are serrated and armed with sharp, recurved prickles. Most of the prickles curve toward the leaf apex but an occasional one curves toward the base. The leaves gradually change from a shiny green to a reddish color as they age. The white or pinkish flowers are produced on a dense panicle that arises from the heart of the plant. The ovoid, pointed fruits are 1 to 2 inches in length and turn yellow at maturity. The main fruiting season is from May to November, although fruit can occasionally be found during the remainder of the year. The small amount of pulp is acid but makes an excellent refreshing drink. It is a fair source of calcium and vitamin C. The pinguin also is a source of a protein-splitting enzyme, pinguinain (*5*). This enzyme can be used as a meat tenderizer, and the juice of the fruit has been utilized as an anthelmintic. The leaves of this plant yield a strong fiber, pinguin, which can be used as a substitute for jute.

The pinguin naturally reproduces vegetatively by means of thick runners that usually are produced above ground. It is usually propagated by separating the runner plants from the parent, but seeds sometimes are used. The pinguin commonly is grown as a hedge plant in Puerto Rico and grows well in soils ranging from the sandy types near the seashore to the clay types of the mountainous interior.

FIGURE 19.—Plant of the pinguin, *Bromelia pinguin.*

FIGURE 20.—Mature fruit of the pinguin, *Bromelia pinguin.*

Byrsonima spicata **(Cav.) L. C. Rich.**
"Maricao" (fig. 21)
Malpighiaceae

The "Maricao," native to many islands of the West Indies and to continental tropical America, forms a medium-sized to large tree that sometimes reaches a height of 70 to 80 feet. The elliptic or lanceolate leaves are 2 to 4 inches in length by about 1 inch in width. The leaves are pubescent when young but nearly free of

hairs when mature. The small yellowish-gold flowers are produced in terminal racemes from June until September. The young twigs and the inflorescences are clothed with reddish hairs. The globose fruits, which mature in the autumn and winter, reach a diameter of up to 1 inch, and contain 3 seeds. The juicy pulp is too acid for eating out of hand but can be used to make jelly or jam. The "maricao" is propagated by seeds which remain viable for at least 1 year.

The closely related Golden Spoon (*Byrsonima crassifolia* (L.)

FIGURE 21.—The "maricao," *Byrsonima spicata.*

H.B.K.) is native to the same area as the "maricao" and also is grown for its edible fruit. The golden spoon varies greatly in form and may be a low shrub or a small tree. The variable-shaped leaves usually are formed in whorls of three. The yellow, acid fruits are about one-half inch in diameter and are called "Nanche" in Mexico, where they are used in soups or meat stuffings, or are eaten raw.

The golden spoon is propagated by seeds. The plants are able to thrive on unproductive soil if it is well drained.

FIGURE 22.—The sapote, *Calocarpum sapota.*

Calocarpum sapota (Jacq.) Merr.
(Syn. *Lucuma mammosa* Gaertn.)
Sapote (fig. 22)
"Mamey Zapote"
Sapotaceae

The Sapote, a native of Central America, forms a large, erect tree that may reach a height of more than 80 feet. The prominently veined leaves are obovate and usually pointed at the tip. They measure up to 12 inches in length by 4 inches in width, and are closely crowded at the ends of the branches. The leaves are light green on the upper surface and lighter green or brownish beneath. The small whitish flowers are produced in great numbers along the branchlets. The russet-brown ovoid or ellipsoid fruits are 3 to 6 inches long. The thick woody skin has a roughened and scurfy surface. The firm, somewhat granular flesh is red to reddish brown and has a rich, sweet flavor. The fruits usually contain one large brown seed; the other four ovules generally abort. The fruits are eaten out of hand, and the pulp can be used to make preserves or a delicious sherbet.

The sapote grows well on heavy soils, and the plants begin bearing within 7 to 8 years from seed. It is commonly propagated by seeds, which have a short storage life. The seeds germinate more readily if the thick husk is removed before planting.

The Green Sapote (*Calocarpum viride* Pitt.) also is native to Central America, where the common name in Spanish is "Injerto." This species and the sapote are similar in habit, but the leaves of the green sapote are smaller and are downy white on the underside. The brownish-green to light-green ellipsoid fruits are up to 5 inches in length. The thin skin surrounds a pale red-brown flesh in which are imbedded 1 or 2 large seeds. The flesh is melting and somewhat juicy and has a better flavor than the sapote. It is eaten out of hand and is used to make preserves.

The green sapote is propagated by seeds, but the seedlings may not come into bearing until 8 to 10 years of age. It does not grow well in the lowlands of the Tropics. In Guatemala it grows best at elevations of 3,000 to about 7,000 feet.

Carissa edulis Vahl. (fig. 23)
Apocynaceae

Carissa edulis is a straggling evergreen shrub native to tropical Africa. It is taller and more vigorous than the karanda. The dark-green leaves measure up to 3 inches in length and usually are elliptical. The jasmine-scented, white or pinkish flowers are borne on axillary or terminal inflorescences containing 5 to 10 flowers each. The flowers are smaller than those of the karanda. The fruits are globose or ovoid in shape, 0.5 to 0.75 inch in diameter, and turn dark purple or black at maturity. The fruit pulp is generally used to make jelly.

Propagation is by seeds.

The Karanda or Christ's Thorns (*Carissa carandas* L.), a native of India, also is grown for its edible fruit. It forms an evergreen thorny shrub smaller than *Carissa edulis*. The small dark-green leaves are elliptical or ovate. The fragrant white flowers, which are produced terminally on branchlets, are characterized by inch-long corolla tubes. The globose fruits are about 1 inch in diameter

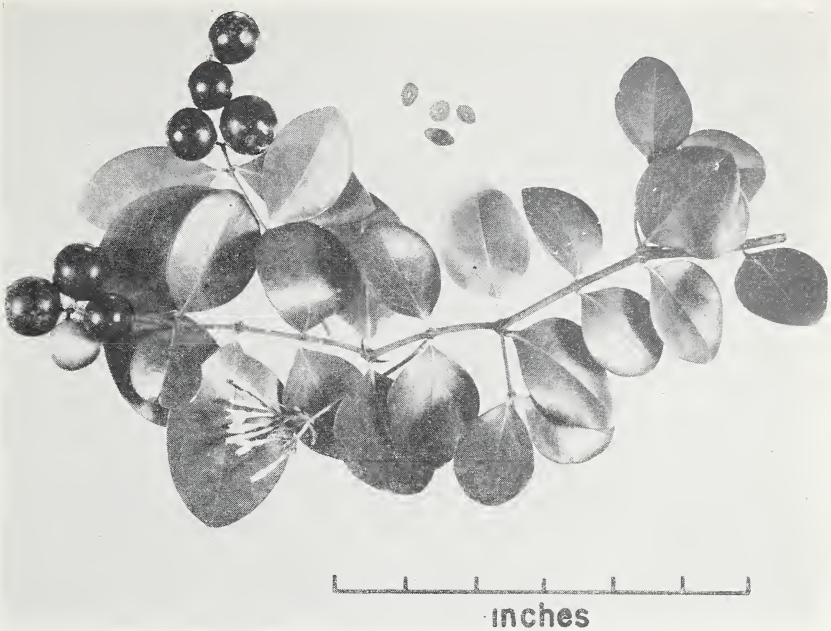

FIGURE 23.—Fruit, flowers, and leaves of *Carissa edulis*.

and are red or purple when mature. Each fruit contains 2 or 3 small seeds. The reddish pulp can be eaten as a dessert fruit or used to make jellies and preserves. In some areas the green fruits are pickled.

The karanda is propagated by seeds. It has value as an ornamental, especially as a protective hedge plant.

***Carissa grandiflora* A. DC.**
Natal Plum, Carissa, Amatungula (fig. 24)
Apocynaceae

The Natal Plum, native to South Africa, is a large shrub or small tree that reaches a height of about 15 feet. The thick, glossy-green, ovate leaves are opposite on branches heavily armed with sharp, branched thorns. The fragrant flowers have long corolla tubes terminated by 5 or 6 white petals that reach a diameter of 1.5 to 2 inches. The plant blooms most profusely in the spring but produces a few flowers throughout the year. The reddish fruits are ovoid to ellipsoid and up to 2 inches long. The papery skin encloses the reddish pulp with a white, milky latex in which are imbedded several small, almost circular seeds. The partly ripe fruits make excellent jelly. The fully ripe fruits are not usually eaten out of hand but make a delicious sauce, which tastes very much like that made from cranberries.

The Natal plum can be propagated by seeds, by cuttings, and by budding. The Natal plum, like the karanda, is valued as a hedge plant and is fruitful even when kept trimmed. It is very useful for hedging around properties close to the ocean because of its tolerance to salt spray and its resistance to damage by wind.

FIGURE 24.—The natal plum or carissa, *Carissa grandiflora.*

***Casimiroa edulis* Llav. & Lex.**
White Sapote (fig. 25)
"Matasano," "Manzana," "Kai"
Rutaceae

This Mexican fruit forms a medium-sized to large erect or spreading evergreen tree. The palmately compound dark-green leaves commonly have 5 leaflets of varying size, the largest 6 to 8 inches in length by about 3 inches in width. The small, inconspicuous, greenish-yellow flowers are borne on both terminal and axillary panicles.

The ovoid fruits are up to 3 inches in diameter and have a thin green skin which turns greenish yellow at maturity. The creamy or yellowish flesh is melting and juicy and has a distinctive sweet flavor. Each fruit has 1 to 5 large ovoid or ellipsoid seeds

FIGURE 25.—The Coleman variety of the white sapote, *Casimiroa edulis*.

imbedded in the flesh. The fruit is picked when fully mature but while still firm; the fruit softens to edible condition in 2 to 3 days. While the fruit can be eaten out of hand, the preferred way is as a dessert fruit with cream and sugar.

A number of white sapote varieties have been selected and named, including Blumenthal, Coleman (fig. 25), Dade, Harvey, Maechtlen, Pike, and Wilson. Mature fruits are sometimes irregular in shape due to the lack of seed development in one or more carpels, and heavy dropping of immature fruits has been reported. Investigations in Florida (*52*) have shown that, although the

flowers of the varieties studied were hermaphroditic, total or partial pollen-sterility may be one factor responsible for the failure of some white sapotes to set a good crop of fruit.

The white sapote can be propagated by seeds, but the seedlings require 7 to 8 years to come into bearing and may produce fruit of inferior quality. The named varieties and improved selections can be propagated readily by shield-budding on vigorous seedlings of the same species. The white sapote is subtropical in its climatic requirements and is best grown in the Tropics at elevations of 2,000 to 7,000 feet.

FIGURE 26.—Flowering and fruiting branches of the cocoplum, *Chrysobalanus Icaco*

A closely related species, the Woollyleaf White Sapote (*Casimiroa tetrameria* Millsp.), is sometimes grown for its fruit. It can be distinguished from the white sapote by its larger leaves with dense white fuzz on the underside, and by its slightly larger fruits.

***Chrysobalanus icaco* L.**
Cocoplum, Icaco (fig. 26)
"Hicaco," "Icaco," "Jicaco"
Rosaceae

The Cocoplum is indigenous to the coastal regions from southern Florida to northern South America, and to tropical Africa. In form, the cocoplum varies from a low, spreading shrub to a small tree with leathery, dark-green, roundish to obovate leaves. The small white flowers are produced in axillary racemes. The mature fruits are 1 to 2 inches in length and ovoid or globular. The thin skin of the fruit varies from pinkish white, to red, to purplish black. The white, cottony pulp adheres to the single large seed and is somewhat insipid in taste. The cocoplum is generally stewed with sugar after the skins have been removed. It can also be used for jelly and jam, and the seeds can be roasted as nuts.

It is usually propagated by seeds but can also be propagated by cuttings.

***Chrysophyllum cainito* L.**
Star Apple (fig. 27)
"Caimito"
Sapotaceae

The Star Apple tree, a native of Central America, is an evergreen that reaches a height of 50 feet or more. The oblong-lanceolate leaves are 2 inches wide and up to 7 inches in length, dark green and smooth on the upper surface and silky golden brown on the under surface. This color combination makes the tree an unusually striking ornamental plant. The purplish-white flowers are small and inconspicuous. The globose fruits range up to 4 inches in diameter and are green or purplish. The fruits do not normally drop and, therefore, must be picked and allowed to ripen off the tree. The common name of this fruit is derived from the starlike appearance of the core when the fruit is cut in cross section. The tough skin surrounds a white, sweet, edible pulp in which are imbedded the small, hard, brown, glossy seeds. The pulp is esteemed as a fresh dessert fruit, but care should be taken to remove the skin, which contains an unpleasant-tasting latex. The pulp sometimes is used in making preserves.

The star apple is usually propagated by seeds, although budding of better selections probably would be satisfactory. It is not tolerant of waterlogged conditions and should be grown on well-drained soils.

A closely related species, the Satinleaf Fruit (*Chrysophyllum oliviforme* Lam.), is sometimes grown for its fruit and as an ornamental. The small fruit is oblong in outline and has an objectionable rubbery skin. The purplish pulp, however, has a good flavor and can be used to make an excellent jelly.

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FIGURE 27.—Fruit and leaves of the star apple, *Chrysophyllum cainito.*

***Coccoloba uvifera* L.**
Sea Grape (fig. 28)
"Uva de Playa," "Uvero"
Polygonaceae

The Sea Grape, native to the sandy seashores of tropical America, usually forms a low shrub but may be a spreading tree 30 to 35 feet in height. The stiff, roundish leaves may measure 8 by 7 inches and have prominent, reddish veins. The attractive appearance of the leaves on the flexuous branches and the resistance of the plant to damage by salt sprays make it valuable as an

FIGURE 28.—The sea grape, *Coccoloba uvifera.*

ornamental for oceanside homes. The small white flowers are produced on slender, hanging racemes 4 to 10 inches long. As many as 40 or 50 fruits may be found on a single cluster, giving the appearance of a bunch of grapes.

The velvety fruits are globose to pear-shaped, about 0.75 inch long, and range from dark purple, to purple, to occasionally off-white. The edible pulp surrounds a globular seed with a short, sharp point on the top. The pulp is sweetish-acid in flavor and is eaten out of hand or is used to make an excellent jelly.

The sea grape can be propagated readily by seeds and by cuttings of ripe wood. In Puerto Rico, the leaves of the sea grape are often attacked by chewing insects, which can be controlled by applications of DDT or similar insecticides.

The fruits of the Pigeon Plum (*Coccoloba floridana* Meissn.) also are eaten to a small extent. The pear-shaped fruits are small,

up to 0.5 inch long, and have a thin layer of acid pulp that is inferior in quality to that of the sea grape.

***Cola acuminata* Schott & Endl.**
Cola Nut, Kola (fig. 29)
Sterculiaceae

The Cola Nut, a medium-sized tree native to West Africa, is now grown in many parts of the Tropics. The leathery elliptic leaves are dark green, keeled at the midrib, and often twisted at

FIGURE 29.—The kola nut, *Cola acuminata*.

the tip. The small flowers, which lack true petals, are borne in clusters of 10 to 15 in axillary and terminal panicles. Both male and perfect flowers are produced on the same inflorescence. The fruit is a follicle, which is corky or rough on the surface and may be 8 inches in length. The ovoid or angular seeds are covered with a white skin that is thin but rather fleshy. Within the seedcoat the seeds are commonly red, but may be pink or white. The cotyledons are tender and succulent but bitter in taste. Cola nuts are chewed for the stimulating effect of the alkaloids caffein and theobromine

FIGURE 30.—The tree tomato, *Cyphomandra betacea*.

they contain. The cola nut is widely grown in West Africa and has particular uses in the social life and religious customs of the people. In Nigeria and the British Cameroons, four species of cola with edible seed have been distinguished (*63*).

The cola nut is usually propagated by seeds but can be propagated asexually by cuttings. The trees are slow growing and require 7 to 10 years to come into bearing. The trees, however, are long-lived and may bear fruit for 75 to 100 years.

Cyphomandra betacea (Cav.) Sendt.
Tree Tomato (fig. 30)
"Palo de Tomate," "Tomate de Arbol"
Solanaceae

The Tree Tomato is generally considered a native of Peru and performs best at medium to high elevations. It is more popular in the Asiatic Tropics, New Zealand, and the Andean region of South America than in the Caribbean region. It forms a shrubby tree 10 to 12 feet high; occasional plants reach a height of 20 or 25 feet and have a trunk diameter of about 4 inches. The large cordate-ovate leaves are soft-pubescent and are 3 to 12 inches long. The small, pinkish, fragrant flowers are produced in April or May in short axillary cymes near the ends of the branches. The mature fruits resemble a hen's egg in size and shape and, in the West Indies, ripen from October to January. The 2-carpeled fruits are orange, red, or purple, depending on the variety. Internally the fruit consists of a meaty mesocarp and tomatolike seeds imbedded in a watery pulp. In flavor it is subacid and is generally considered to resemble the garden tomato (*Lycopersicon esculentum* Mill.). The fruit may be cut and eaten raw but is most commonly stewed to form a conserve. It can also be made into jam or preserves. Unlike the garden tomato, the seeds and skin of the tree tomato should be removed before cooking.

The tree tomato is usually propagated by seeds, but select strains may be grown from cuttings. Growth is rapid; the plants bear fruit the second year and continue in production for 10 to 12 years.

Dillenia indica L.
Dillenia (fig. 31)
"Dilenia"
Dilleniaceae

The Dillenia, native to tropical Asia, forms a handsome evergreen tree that is well suited for ornamental purposes. The trunk usually branches a few feet above the ground, forming a spreading tree that reaches a height of 20 to 25 feet. The oblong or obovate, toothed leaves are up to 12 inches in length and have many conspicuous parallel veins. The leaves are shiny dark green above, light green beneath, and are confined to the ends of the branches. The beautiful, solitary, white flowers are very large, sometimes measuring 9 inches in diameter. After flowering, the petals drop and the persistent calyx again closes and develops to form a thick fleshy covering enveloping the fruit. The fruit, together with its protective covering, measures 5 to 6 inches in diameter. The many-seeded true fruit is greenish yellow and surmounted by the persistent, slender, spreading rays of the stigma. The juicy pulp is aromatic but very acid and requires cooking.

FIGURE 31.—Fruit and leaves of the dillenia, *Dillenia indica*.

The dillenia can be propagated readily by seeds but with difficulty from cuttings. It can be grown on many types of soils but does best in light sandy loams.

***Diospyros discolor* Willd.**
Velvet Apple (fig. 32)
"Mabolo"
Ebenaceae

The Velvet Apple, native to Malaya, is a medium-sized to large evergreen tree and makes a handsome ornamental. The oblong-

FIGURE 32.—The velvet apple, *Diospyros discolor*.

acute leaves are 4 to 10 inches long, shiny green on the upper surface, and orange-pubescent underneath. The white waxy flowers have 4 petals and are about 0.5 inch in diameter when fully open. The fruits are about 3 inches in diameter with a velvety, dull-red or orange skin. Most fruits develop without seeds and are flattened-globose in shape. Those that develop seeds, however, are elongated and very similar in shape to the apple (*Pyrus malus* L.). The soft, mealy flesh is whitish and aromatic. Some people find the odor unpleasant, similar to that of strong cheese, but the pulp has a pleasant taste. The main crop of the velvet apple is produced between June and Setember, but a few fruits can be found on the tree most of the year.

The velvet apple usually is propagated by seeds but also can be marcotted.

A closely related species, the Black Sapote (*Diospyros ebenaster* Retz.), is grown to a limited extent in its native home, Mexico. Ripe fruits of the black sapote usually are larger than those of the velvet apple and are olive green. The soft pulp is dark chocolate and of sweet flavor. The black sapote is propagated by seeds.

***Dovyalis caffra* (Hook. & Harv.) Warb.**
(Syn. *Aberia caffra* Harv. & Sonder.)
Kei Apple (fig. 33)
Flacourtiaceae

The Kei Apple, native to South Africa, is a vigorous-growing evergreen shrub or small tree armed with long, stiff, sharp thorns that make it an excellent hedge plant. The small leaves are oblong-ovate and shiny green. The yellowish-cream flowers are small and inconspicuous. The ovoid to globular fruits are 1 to 2 inches in diameter. They have a thin, yellow skin, and yellow, juicy, aro-

FIGURE 33.—Fruiting branch and sectioned fruit of the kei apple, *Dovyalis caffra*. (Courtesy of Mrs. Julia Morton.)

matic pulp in which are imbedded many small seeds. The very acid pulp is separated from the seeds and is used to make jam and jelly. The pulp is high in pectin and small amounts of it will cause good jelling of other fruit juices that do not jell well.

The kei apple grows well on a wide range of soil types and is able to withstand considerable drought. Cross-pollination of the flowers is necessary, as the male and female flowers are produced on separate plants. The kei apple can be propagated by seeds, but the resulting plants may all be of one sex. Thus, it is best to propagate it asexually from plants of known sex. One male plant will provide sufficient pollen for several female plants.

***Dovyalis hebecarpa* (Gardn.) Warb.**
(Syn. *Aberia gardneri* Clos.)
Ceylon Gooseberry, Ketembilla (fig. 34)
"Quetembila"
Flacourtiaceae

The Ceylon Gooseberry, native to Ceylon, derives its common name from that country coupled with the similarity of the fruit to the gooseberry (*Ribes hirtellum* Michx.). It forms a small, spreading tree that rarely reaches a height of more than 20 feet. The older branches sometimes are armed with stout, sharp thorns. The pale-green lanceolate leaves are 3 to 4 inches in length. The petiole and main veins are pinkish red, the color more prominent on the under than on the upper surface of the leaves. The leaf is not flat but is curled and sometimes twisted at the tip. The small greenish-yellow flowers are produced in abundance several times a year. Although occasional plants produce perfect flowers, most trees have either male or female flowers and both must be planted together, therefore, to insure fruit set. The globular fruit is

slightly less than an inch in diameter. The reddish-purple velvety skin encloses an acid, purplish pulp that contains many small seeds. Mature fruits of the Ceylon gooseberry are not usually eaten out of hand but make an excellent conserve when stewed with sugar. The half-ripe fruits can be made into jam and jelly.

This fruit can be propagated by seeds, but superior strains should be perpetuated by budding or grafting.

A closely related species, *Dovyalis abyssinica* (A. Rich.) Warb., also is sometimes grown for its edible fruits. It produces a plant similar in habit to the Ceylon gooseberry, but the leaves are larger, elliptic rather than lanceolate, and the petiole and main veins are light green. Male and female flowers are borne on separate plants. The fruits are similar in shape to the Ceylon gooseberry but are slightly larger and contain fewer seeds. The subacid fruits are more desirable for eating out of hand than are those of the Ceylon gooseberry. It can be propagated by seeds and by grafting.

Controlled crosses among the species of *Dovyalis* may result in superior types. In South Florida, seedlings of a recent cross between *D. hebecarpa* and *D. abyssinica* have shown great variation in fruit characters. Fruits of the better ones are larger than either of the parents but have a flavor resembling that of *D. abyssinica.*

FIGURE 34.—The Ceylon gooseberry, *Dovyalis hebecarpa.*

***Durio zibethinus* Murr.**
Durian (fig. 35)
Bombacaceae

The Durian is a tall Malaysian tree that may reach a height of 100 feet or more. The oblong-lanceolate leaves are 6 to 8 inches long and shiny dark green above and light golden yellow beneath. The leaves are fragrant when crushed. The large whitish flowers

are produced in lateral cymes and have an unpleasant odor. The ovoid to ovoid-oblong, greenish-yellow fruits may be 5 to 6 inches in diameter and 6 to 12 inches in length. They have a thick fibrous rind covered with coarse, sharp, pyramidal spines. The fruit is 5-valved with 2 to 6 seeds in each division. The seeds are imbedded in a buttery, whitish pulp, which is the edible portion. Although highly esteemed in its native home for its delicious flavor, the strong rotten-onion smell of the durian is offensive to most people eating this fruit for the first time. In addition to the pulp, which is eaten both fresh and cooked, the seeds are consumed after roasting or after being cut into slices and fried.

The durian usually is propagated by seeds, but improved forms can be budded readily on seedlings of the same species.

***Elaeagnus philippensis* Perr.**
Lingaro (fig. 36)
Elaeagnaceae

The Lingaro, native to the Philippine Islands, is a shrubby evergreen vine. The small alternate leaves are elliptical and are light green on the upper surface and thickly dotted with scales

FIGURE 35.—A fruit and leaves of the durian, *Durio zibethinus*.

FIGURE 36.—The lingaro, *Elaeagnus philippensis.*
(Courtesy of Mrs. Julia Morton.)

beneath. The small but numerous flowers have a pleasant, jasmine-like odor. The dull pink fruits are about 0.75 inch long and capped by the persistent calyx tubes. The subacid juicy pulp surrounds a single seed. The fruits can be eaten out of hand but are more commonly used to make an excellent jelly of a clear bright color.

In southern Florida the plant has grown well on dry rocky soils but responds well to good cultural practices. Although it grows as a shrub if left unmolested, with proper pruning it can be trained readily on a trellis or wall and has value as an ornamental plant.

The lingaro is propagated by seeds and by cuttings.

Eriobotrya japonica (Thunb.) Lindl.
Loquat (fig. 37)
"Níspero de España," "Níspero de Japón"
Rosaceae

The Loquat, forms a small handsome evergreen tree that is grown for its ornamental value as well as for its edible fruits. While native to central-eastern China, it is now cultivated in many parts of the world, particularly Japan. The thick, obovate or oval-oblong leaves are shiny green on the upper surface and downy white on the lower surface. All parts of the tree are covered with a white or gray down. The small, white, very fragrant flowers are borne in profusion on small terminal panicles. Since it is reported that the flowers are self-incompatible, several trees should be planted close to each other to assure cross-fertilization. The downy, pale-yellow to orange fruits are 1 to 3 inches long and are obovoid or pear-shaped. The flesh is usually yellow or light orange and has a mild subacid and sweet flavor. A fruit may

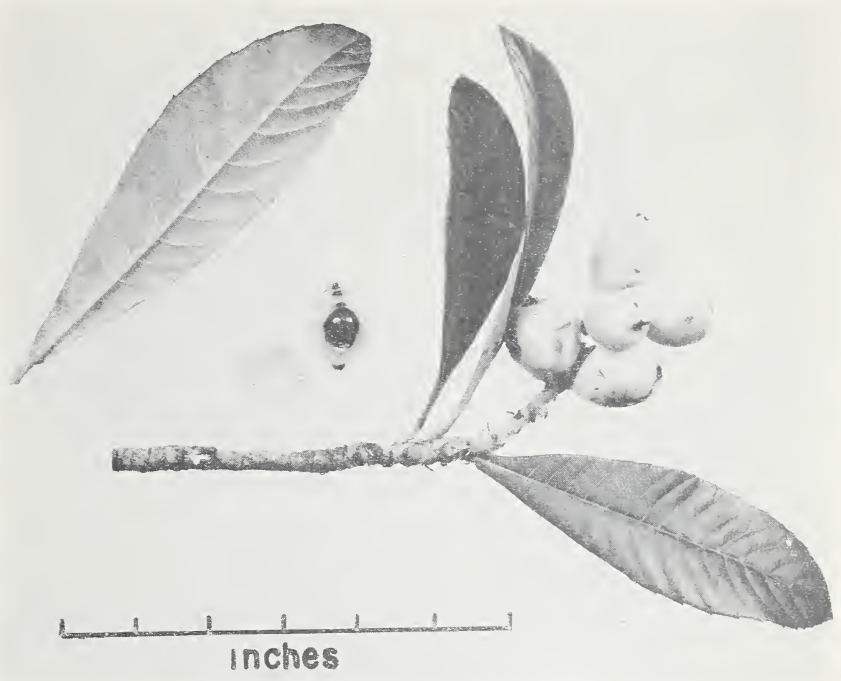

FIGURE 37.—Foliage and fruit of the loquat, *Eriobotrya japonica.*

contain as many as 10 seeds, but usually not more than 3 to 5. Strains that uniformly produce one seed per fruit have been reported. The pulp can be eaten fresh but is usually stewed, and can be used to make an excellent jelly.

In the Tropics the loquat does not fruit well in the coastal regions but can be successfully grown at elevations of 1,500 to 6,000 feet. The loquat is subject to attack by fire-blight, a bacterial disease, which sometimes causes blossom-blight and twig die-back. It is best controlled by removing and burning the affected parts and by applying little nitrogen so that the trees do not become vigorously vegetative. Better quality fruit on some seedlings suggests that breeding and selection work would result in better varieties for the Tropics. It has been reported that over 800 varieties are cultivated in Japan. Improved strains and named varieties can be propagated by budding or cleft-grafting on seedlings of the same species or on quince (*Cydonia oblonga* Mill.).

***Eugenia jambos* L.**
(Syn. *Syzygium jambos* Alston)
Rose Apple (fig. 38)
"Pomarrosa"
Myrtaceae

The Rose Apple, native to the East Indies, forms a handsome evergreen tree 25 to 30 feet high, which is prized as an ornamental. The glossy, leathery leaves are lanceolate and pointed, being 6 to 8 inches in length and 2 inches or less in width. The new leaves

FIGURE 38.—The rose apple, *Eugenia jambos.*

are wine colored and gradually turn to the characteristic dark green at maturity. The flowers are produced in short, terminal racemes on the young branchlets and have many conspicuous greenish-white stamens about 1.5 inches in length. The ovoid or globular fruits are up to 2 inches in length and are white or pale yellow, usually with a faint pink blush. The fruit has a thin layer of pale yellow flesh and 1 to 3 brown seeds, which lie loose

in a large, hollow seed cavity. The flesh is rose scented, crisp, juicy, and sweet. It is sometimes eaten out of hand but is more generally used to make jelly and jams. It also can be stewed or preserved in sirup.

The rose apple usually is propagated by seeds, which remain viable for only a short time after being removed from the fruit. The seeds are unusual in that they are polyembryonic—as many as 7 or 8 plants may arise from a single seed. The rose apple grows well on a wide range of soil types. It grows rather slowly, and comes into bearing in 4 to 5 years from seed. Select strains may be propagated by budding.

The Grumichama, *Eugenia dombeyi* (Spreng.) Skeels, is another species grown for its edible fruit (fig. 39). It is a small to medium-sized tree from Brazil with dark-green, glossy, oval to obovate leaves 3 to 5 inches in length. The dark-crimson, roundish fruits are 0.5 to 1 inch in diameter and have long stems. The thin skin surrounds a soft flesh that has a pleasant, sweet flavor. The fruits can be eaten out of hand or used to make jam or jelly. In Cuba the tree is reported to be shallow-rooted and to suffer severely during the long dry season. The grumichama is propagated by seeds.

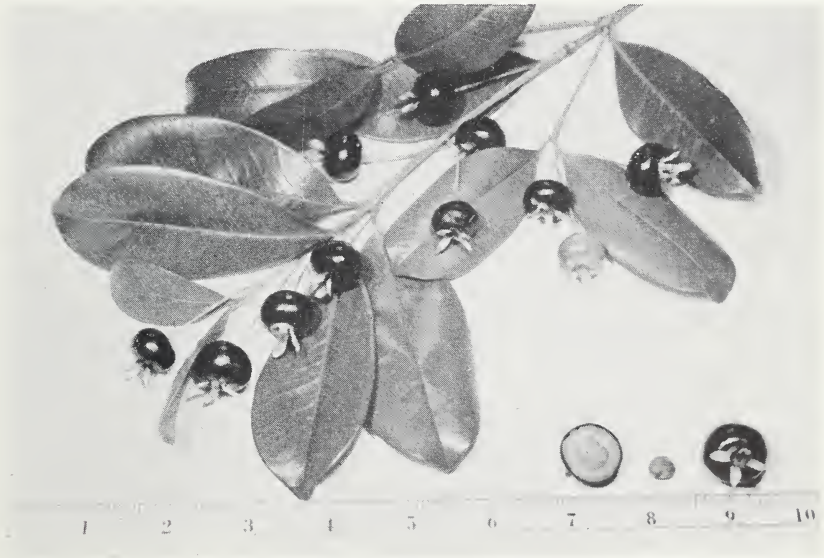

FIGURE 39.—The grumichama, *Eugenia dombeyi*.
(Courtesy of Mrs. Julia Morton.)

***Eugenia malaccensis* L.**
Malay Apple (fig. 40)
"Pomarrosa Americana"
Myrtaceae

This Malayan fruit forms a handsome, evergreen tree of pyramidal shape, which may reach a height of 30 to 35 feet. The oblong to elliptic acute leaves are 6 to 10 inches long and 2 to 4 inches

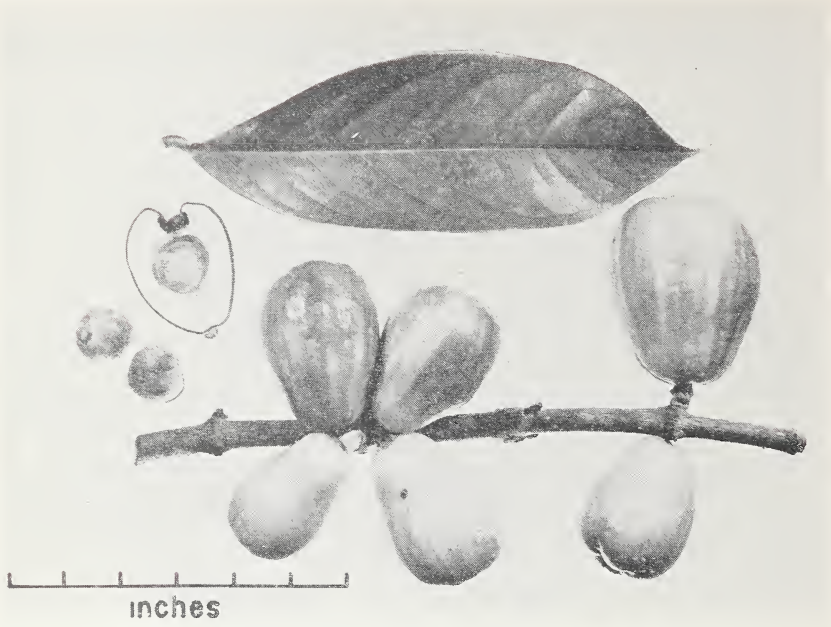

FIGURE 40.—The Malay apple, *Eugenia malaccensis*.

in width. The bright-red or purple flowers, produced directly on the trunk and branches, are characterized by many long stamens with crimson filaments. Each flower lasts only a short time, and during blossoming the ground under the tree is carpeted with the fallen petals and stamens. The pear-shaped fruits may be 4 inches long by 3 inches wide and are reddish pink with longitudinal stripes and splashes of darker red. The thick, white, somewhat dry flesh surrounds a single large seed. The Malay apple has a distinct rose odor and a somewhat insipid taste. The fruits may be eaten fresh but usually are stewed with some flavoring material such as cloves. The pulp also can be used to make jelly. It is a fair source of iron.

In addition to the use of seeds, the Malay apple can be propagated by budding on stocks of the same species.

Eugenia uniflora L.
Surinam Cherry, Pitanga (fig. 41)
"Cereza de Cayena"
Myrtaceae

Unlike most other members of this genus, which are native to southeastern Asia, the Surinam cherry is indigenous to tropical Brazil. It forms a large shrub or small tree approximately 20 feet in height. The small, opposite, ovate-lanceolate leaves are glossy green, but immature leaves have a coppery color that adds to the ornamental value of this plant. The small cream-colored flowers are produced in profusion in the axils of the leaves. The fruits are deeply 8-ribbed and usually about 1 inch in diameter, although plants bearing fruits nearly 2 inches in diameter have been reported. The mature fruits range from light to dark red, to

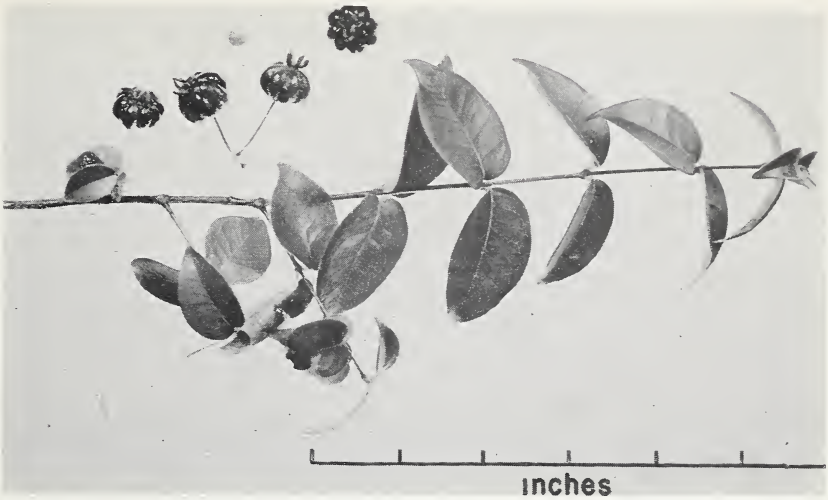

FIGURE 41.—The Surinam cherry, *Eugenia uniflora.*

almost black, and have flesh of about the same shade. The juicy, sweet-acid pulp encloses 1, or sometimes 2, fairly large seeds. The Surinam cherry is probably the best of the edible eugenias and is an excellent fresh fruit. It also can be used to make pies, jellies, and jams. The pulp is a good source of calcium, and a fair source of phosphorus and iron.

It usually is propagated by seeds, but cleft-grafts also have been used successfully. The Surinam cherry makes an excellent hedge, flowering and fruiting even when severely pruned.

***Ficus carica* L.**
Fig (fig. 42)
"Higo," "Higuera"
Moraceae

The cultivated Fig, native to the arid region of Asia Minor, forms a shrub or low-spreading deciduous tree. The large, wavy-margined leaves are usually 5-lobed but may have only 4 or 3 lobes. The leaves are conspicuously palmately veined, especially so on the under surface. The small flowers are produced twice in the season. The first ones are produced near the ends of the shoots of the preceding flush of growth, whereas the second crop is produced in the axils of the leaves on the new growth. The mature fruit is pear-shaped and variable in size and color depending on the variety. The edible fruit is a hollow succulent receptacle with many ovaries on the inner surface, which may or may not produce seeds, again depending on the variety.

Figs are consumed fresh and after sun or artificial drying. They have been an important fruit of commerce in the eastern Mediterranean region since antiquity, and today are grown in many parts of the world. Figs have a high sugar content and are a fair source of vitamins A, B, and G (B_2). A comprehensive bibliography of the fig has recently been compiled by Condit and Enderud (*18*).

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The process of pollen transfer and subsequent fruit set is unusual and complex, since flowers of edible figs do not produce pollen. Some varieties, *i.e.*, Mission, Celeste, and Kadota, set seedless fruits parthenocarpically. On the other hand, many varieties require pollen from a kind known as caprifigs. The pollen is transferred from the caprifig to the edible fig by a small wasp. Without the caprifigs and the wasp, flowers of these varieties will not set fruit. Recent work in California has shown, however, that some fig varieties can be induced to set seedless fruits by the application of synthetic growth regulators (*19*). Figs so treated not only developed without the aid of pollination but also matured more quickly than the seeded ones. The varieties that normally

FIGURE 42.—The fig, *Ficus carica.*

develop seedless fruits are recommended where only a few trees are to be planted.

Fig trees are readily propagated by cuttings, but budding or grafting also has been used to topwork a tree to a better variety. Fig trees are tolerant of poorly drained soils and grow well in relatively infertile soils. They are, however, susceptible to root-knot nematode and should not be planted in areas where this minute worm is known to be a problem. In the Tropics, figs grow best at the higher elevations and in areas of low rainfall during the flowering and fruiting seasons.

***Flacourtia indica* (Burm. f.) Merr.**
(Syn. *F. ramontchi* L'Her.)
Governor's Plum (fig. 43)
"Ciruela Forastera"
Flacourtiaceae

The Governor's Plum, a native of tropical Africa and Asia, forms a shrub or small tree, sometimes sparsely armed with sharp, stout thorns. The shiny, alternate leaves are oblong to elliptical with lightly serrated edges and short petioles. The very small flowers are produced in short racemes from the leaf axils. The subglobose fruits may be slightly over 1 inch in diameter, are purplish red or blackish, and are surmounted by the remains of the pistils. The reddish juicy pulp encloses 8 to 10 small seeds. The fruits may be eaten fresh or used in jams and jellies.

The governor's plum is most often propagated by seeds, but cuttings of mature wood have been rooted successfully. Since male and female flowers usually are produced on separate trees, care should be taken to propagate plants of both sexes.

The Lovi-Lovi, *Flacourtia inermis* Roxb., is another species of the genus that produces an edible fruit. It forms an open-growing tree that attains a height of 15 to 25 feet. The ovate to elliptic leaves are shiny green on the upper surface and lighter green beneath. The small flowers are bisexual so that a single tree can be expected to produce fruit. The subglobose fruits are dark red when mature and contain many small seeds. The fruits usually are too astringent to be eaten raw but make excellent jams and preserves. Sweet forms suitable for eating out of hand are reported to exist. The lovi-lovi can be propagated by seeds but the seedlings are variable in plant and fruit characters. Improved strains can be propagated by marcotts and by budding on seedlings of the same species or of the rukam.

***Flacourtia rukam* Zoll. & Mor.**
***Rukam* (fig. 44)**
Flacourtiaceae

The Rukam, a native of the Philippines and the Malay Archipelago, is a low tree 20 to 25 feet in height. It often branches near the base of the trunk, which gives it a shrublike appearance. The glabrous, oblong-lanceolate leaves are dark green on the upper surface, pale green on the under surface, and 6 to 9 inches in length. The leaf edges are more deeply serrated than those of the governor's plum. The small flowers are produced in racemes of a few to many flowers. The fruits are dark purple when ripe and have persistent pistils, although they are not so noticeable as those on fruits of the governor's plum. The juicy, sour pulp con-

FIGURE 43.—The governor's plum, *Flacourtia indica*.

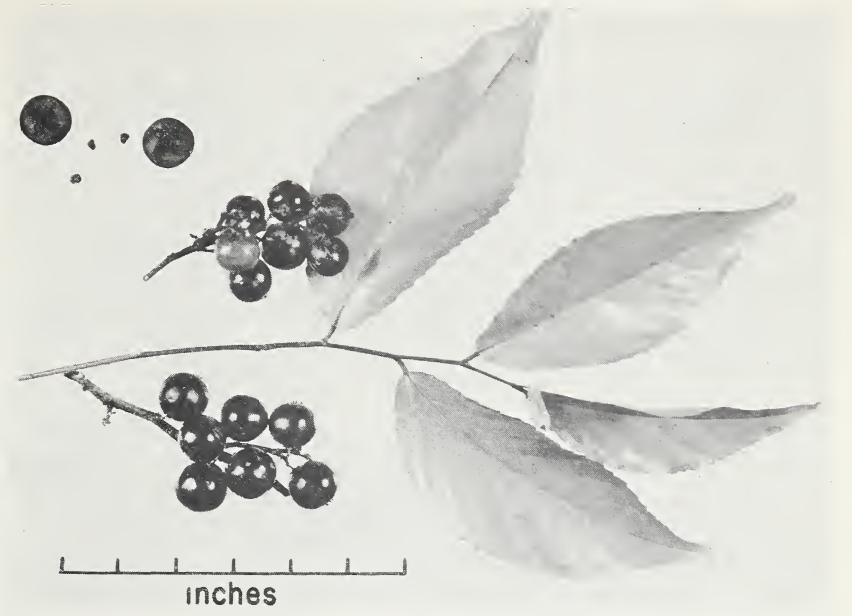

FIGURE 44.—Fruit and leaves of the rukam, *Flacourtia rukam*.

tains many small seeds. The fruit can be eaten raw and can be used to make jellies and preserves. In Malaya the young tender leaves are eaten in salads.

The rukam can be propagated by seeds and, asexually, by root-suckers and by budding on seedlings of the same species or on those of the lovi-lovi. Like the governor's plum, the rukam usually is dioecious and trees of both sexes should be planted to insure fruit-set.

Fragaria hybrids
Strawberry (fig. 45)
"Fresa"
Roseaceae

The Strawberry is distinctly Pan American in origin. Most of the common varieties grown today have resulted from hybridizing two species, *Fragaria virginiana* Duchesne and *F. chiloensis* Duchesne. The former is native to eastern North America, and the latter is indigenous to the west coasts of both North and South America.

The strawberry is a stemless, low, perennial, creeping herb, which produces runners chiefly after the blooming period. The leaves are palmately 3-foliate and arise from the crown of the plant. Individual leaflets are obovate and have serrated or toothed edges. The white to yellowish flowers are 1 inch in diameter and are produced in clusters of 3 to 7 on slender, leafless scapes which, like the leaves, arise from the crown of the plant. The ovoid fruits are 1 to 2 inches in length and vary in color from light to dark red. The edible portion is an enlarged, fleshy receptacle and has a delicious flavor. It is a good source of vitamin C. The true

fruits are the small hard achenes found in slight depressions on the surface of the receptacle.

The strawberry is an excellent dessert and jam fruit and deserves to be more widely grown in the Tropics. Tests in Puerto Rico have shown that the strawberry grows and fruits poorly in the coastal areas, but that growth and production are satisfactory when the plants are grown at elevations of 1,000 feet or more.

Many varieties of strawberries have been selected and named, and the industry is of major importance in many temperate and subtropical areas of the world. The varieties now grown in the southern United States, such as Missionary and Blakemore, are recommended for trial, although investigation probably would result in varieties specifically adapted to the Tropics.

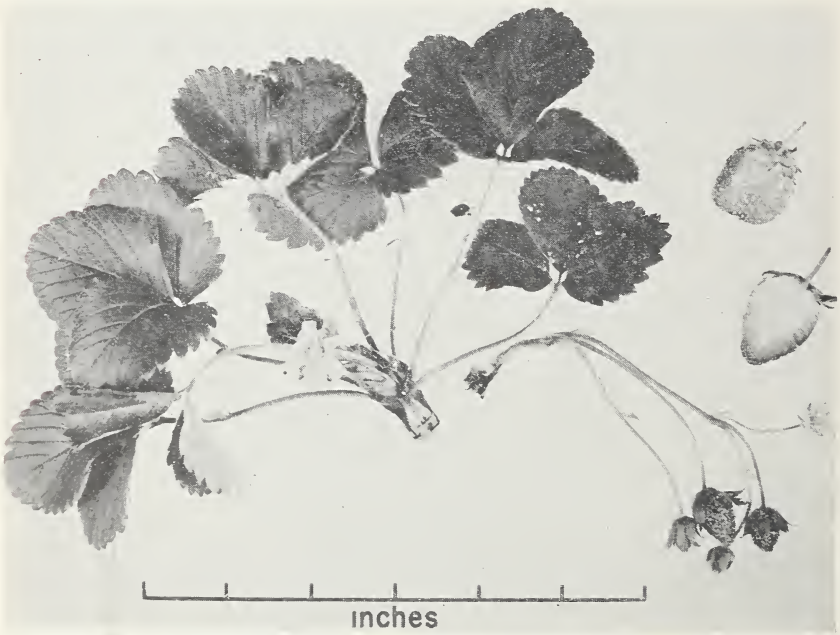

FIGURE 45.—The strawberry, *Fragaria* hybrids.

The strawberry usually is propagated by runners that are severed from the parent plant. If runners are not produced, it can be propagated by division of the old plants. In cool climates strawberries are set out at a spacing distance of 1 foot between plants and 3 feet between rows. All flower buds should be removed the first season to encourage the production of runners and the establishment of a bed of plants. In Puerto Rico, the varieties tested have produced very few runners, so plants should be set out 1 foot on the square. A strawberry bed of about 50 plants should supply the needs of the average family, as they tend to fruit continuously in the Tropics. Individual fruits ripen about 1 month

after flowering. Strawberry beds should be completely replanted annually, or in 2 to 3 years when production begins to decline.

The strawberry is attacked by a number of insects and diseases, but with reasonable precautions in culture there is no need for a regular spray program.

Garcinia livingstonei T. Anders.
Imbe (fig. 46)
Guttiferae

This small tree of Portuguese East Africa bears an edible plum-like fruit. Although the trees may reach a height of 15 to 20 feet, they are usually lower and have several trunks, which arch away from the main axis and produce a number of short, thick, side branches. The trees are often used as landscape subjects because of their unusual form. The oblong dark-green leaves are leathery in texture and have white veins. They measure from 4 to 6 inches long and from 1 to 2 inches wide. Greenish-yellow flowers are produced in clusters along the branches at the beginning of the rainy season.

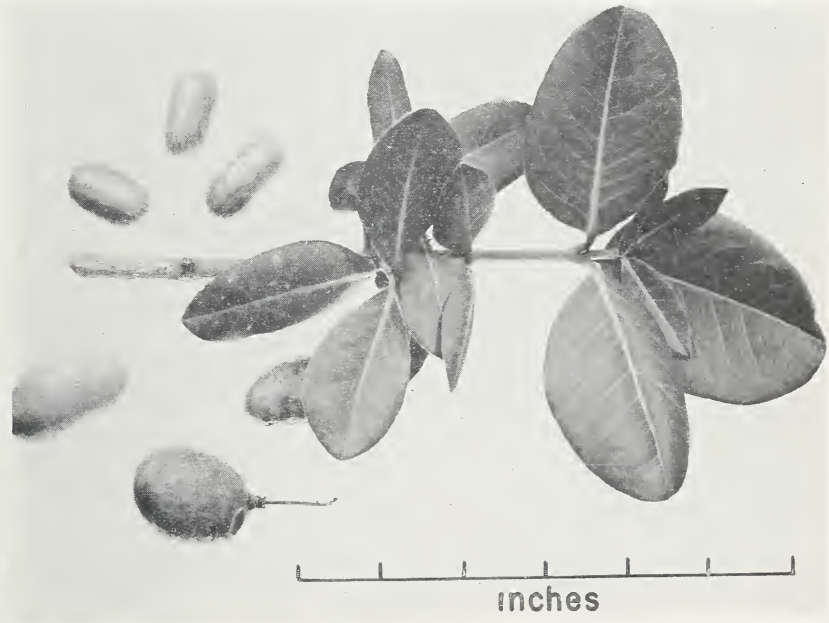

FIGURE 46.—The imbe, *Garcinia livingstonei.*

The fruit ripens a dull to bright orange color in July and is gone in 2 weeks. It measures 1.5 to 2 inches in length and 1 to 2 inches in diameter. While usually 1-seeded, an occasional fruit produces 2 seeds. A thin layer of acid-sweet watery pulp surrounds the seed. The rather tender skin tends to prevent packing and shipping of the fruit, but it deserves to be more widely cultivated as a home fruit.

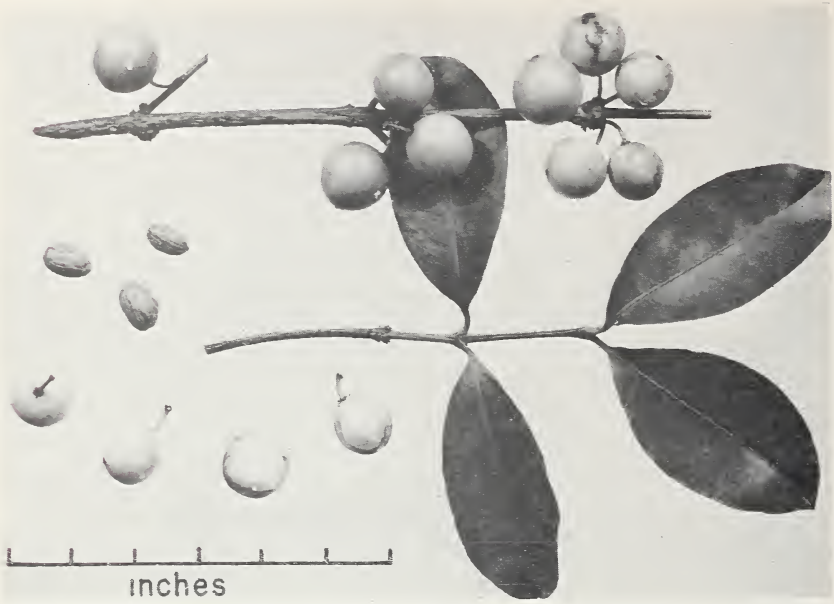

FIGURE 47.—Fruit and foiliage of *Garcinia dulcis*.

The trees are not particular in their soil requirements but respond to good culture. They tolerate a 4- to 5-month dry season without being irrigated. Propagation is by seeds. The imbe is a stock on which the mangosteen can be grafted.

Several other species of *Garcinia* produce fruits that may be eaten although not of top quality. *G. xanthochymus* Hook. f. is a small to medium-sized tree of Southern India and Malaya. It bears leathery leaves 10 to 15 inches long and about 3 inches wide. The smooth, yellow fruit is the size of a small orange and has a pointed stigmatic end. The edible, yellow pulp is juicy and has an acid flavor.

Another species, *G. dulcis* (Roxb.) Kurz (fig. 47), is a medium-sized tree that bears prolific crops of pale-orange, plumlike fruits, 1 inch in diameter. The fruits may be eaten fresh or made into jam.

Neither of the latter species is common in the Western Hemisphere outside of botanical collections. Propagation of both is by seeds.

Garcinia mangostana L.
Mangosteen (fig. 48)
"Mangostín"
Guttiferae

No other tropical fruit has been so highly praised as the Mangosteen. The combination of beautiful coloring and interesting shape with a delicate, enticing flavor ranks it above all other fruits of the Asiatic Tropics. The mangosteen has none of the insipid flavor ascribed to many tropical fruits, and it is almost universally liked by individuals tasting it for the first time.

FIGURE 48.—The mangosteen, *Garcinia mangostana.*

The mangosteen is thought to be native to the Malay Peninsula and to the Molucca and Sunda Islands. It is extensively cultivated in the more humid parts of the Asiatic Tropics. The tree is an attractive columnar or pyramidal slow-growing evergreen, which attains a height of 30 to 40 feet. It has a strong central trunk with evenly spaced side branches, which become pendent at the tips as the tree ages. The leathery leaves are opposite, short-stalked, and elliptic-oblong with acuminate tips. The upper surface is bright,

shining green; the under surface is a dull green. All parts of the plant are without pubescence. The 2-inch fleshy flowers are borne terminally upon the branchlets.

The subglobose fruit, which is 1.5 to 3 inches in diameter, ripens a dark reddish-violet to purple color. It may be smooth or marked with brownish scars. The thick, tough pericarp or rind exudes a bitter yellowish resin, especially when unripe. The calyces and stigmatic lobes persist until the fruit is ripe, and the number of stigmatic lobes is indicative of the number of internal segments. The fruit is opened by an equatorial cut through the rind to expose 5 to 8 translucent white segments, which are easily separated from the rind. The juicy pulp has a sweet-tart flavor, which is generally accepted by people from temperate and tropical climates alike. Usually only 1 to 3 of the segments contain seeds, which are oblong bodies about 1 inch long and 0.3 inch in diameter.

The mangosteen is best propagated by seeds, which should be planted within a few days after removal from the fruit. Flats of peat moss have proved excellent for germinating the seeds. When the plants reach the 2-leaf stage they should be moved to heavily shaded outdoor nurseries. After the plants become established the light may be gradually increased to about one-half of full sunlight. After 2 to 3 years in the nursery, the seedings may be transplanted to the field. It is necessary to move the plants with large balls of soil intact about the roots. Shading is important after this transplanting also, but the plants should be adjusted to full sunlight in about 2 years.

Seedling mangosteen trees may be expected to bear fruit in 8 to 15 years, depending on the location, care, and vigor of the tree.

The mangosteen tree grows well in fertile clay or loam soils. Good drainage seems to be important, but the tree does well near lakes or streams. While high humidity and rainfall seem to benefit the trees, they will produce in areas having a dry season of several months. Fertilization with animal manure seems to benefit the trees.

Genipa americana L.
Marmaladebox Genip (fig. 49)
"Jagua"
Rubiaceae

The Marmaladebox Genip is a popular fruit in Puerto Rico and parts of Brazil. A native of the West Indies and the adjoining area of northeastern South America, it is not well known outside the area. The medium-sized tree is usually rather coarse in appearance because of its stoutish trunk and sparse foliage. In full foliage its dark-green shining leaves can make it handsome. The leaves, which are oblong-obovate and up to a foot in length, are clustered at the branch tips. The medium-sized tubular flowers are creamy white on opening but become yellow the second day.

The ovoid fruits measure about 4 inches in length and 3 inches in diameter. When immature they are gray and often spotted with lichens. At maturity the color changes to tan or russet-brown and the flesh softens. Beneath the thin skin a layer of granular flesh surrounds the seed cavity where numerous small compressed seeds are embedded. The fruits are harvested when mature and allowed to soften before use. In Puerto Rico a refreshing drink

FIGURE 49.—The maraladebox genip, *Genipa americana.*

is made by macerating the ripe fruits in water. In this condition they have a strong pungent aroma, but will keep for some time before actual decay sets in. The fruit is seldom eaten out of hand. It is a rich source of iron and riboflavin (*7*) and recently has been found to contain an antibiotic substance.

The marmaladebox genip tree grows best in deep rich loam or clay soils. It develops best in a humid atmosphere with ample soil moisture but will thrive in areas with a 3- or 4-month dry season. It is propagated by seeds, which germinate in 1 week or less after planting. Nothing has been done in the selection of superior

varieties, but the people of Puerto Rico recognize differences among seedling trees.

Grewia asiatica L.
Phalsa (fig. 50)
Tiliaceae

The Phalsa is a large shrub with several trunks or sometimes a small tree, 12 to 15 feet high. It is grown for its agreeable, subacid fruit, which is used in preparing cooling drinks. A native of India, it is often included in botanical collections in other tropical areas.

Stems arise from the base of the plant and may reach 12 feet without branching. The irregularly toothed leaves vary in size but may reach 5 inches in length and 4 inches in width. They are rounded or heart shaped. Both upper and lower surfaces of the leaves, as well as the young branches, are covered with star-shaped hairs.

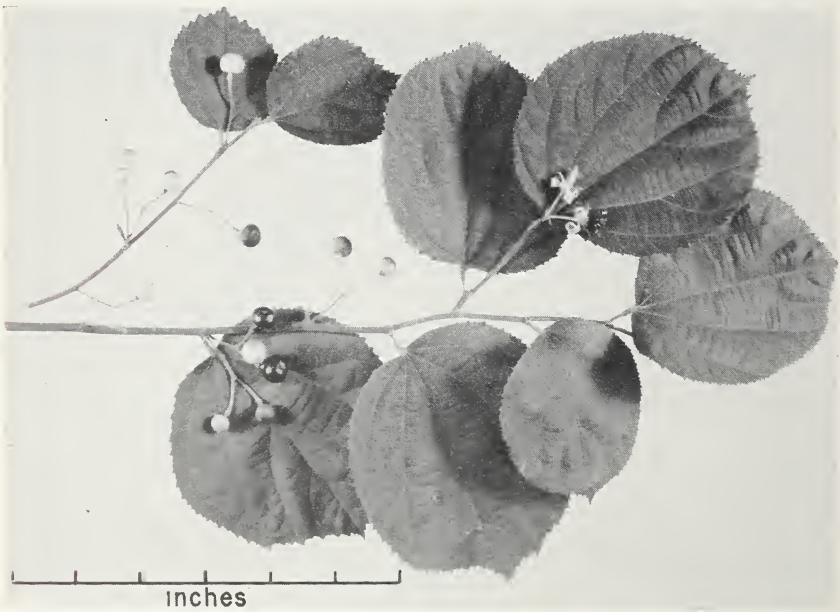

FIGURE 50.—Fruit, flowers, and foliage of the phalsa, *Grewia asiatica.*

The yellow-orange flowers are borne in small clusters in the axils of the leaves. The curled sepals are longer than the petals and are colored like them. Flowering occurs from May to July at Mayaguez, fruiting from July to August.

The globose, berry-like fruit is dark purple at maturity, about 0.4 inch in diameter, and has 1 or 2 small stones. When ripening, the fruit color changes from green through red to purple. All stages may be seen at the same time. The slightly acid, sweet fruits are macerated in water to prepare a drink, or the pulp may be used in sherbet or jam.

During the latter part of the dry season the long branches should be pruned back almost to the trunk, as the fruits are borne on new growth. Propagation is by seeds or layering. Seedlings come into bearing the second year.

***Guilielma gasipaes* (H.B.K.) Bailey**
Peach Palm (figs. 51 and 52)
"Pejibaye"
Palmaceae

This handsome, slender, spiny palm, a native of tropical America, is found at abandoned Indian campsites near the Carribbean coasts of Central and South America. It is cultivated to a limited extent in parts of this area.

FIGURE 51.—Plant of the peach palm, *Guilielma gasipaes*, 25 feet tall.

The trunks, which reach 30 feet in height, grow singly or a few clustered together. The feathery leaves, which may reach 6 feet in length, are dark green on top and light green on the underside. Both the midrib and sheath of the leaves bear spines, as do the trunks.

Clusters of red or yellow fruit are borne below the foliage and are said to weigh up to 25 pounds. The individual fruits are ovoid to ellipsoid and measure about 2 inches in length. Some varieties are seedless or contain only small seeds. They are prepared for eating by boiling in salt water or roasting, when they have a sweet

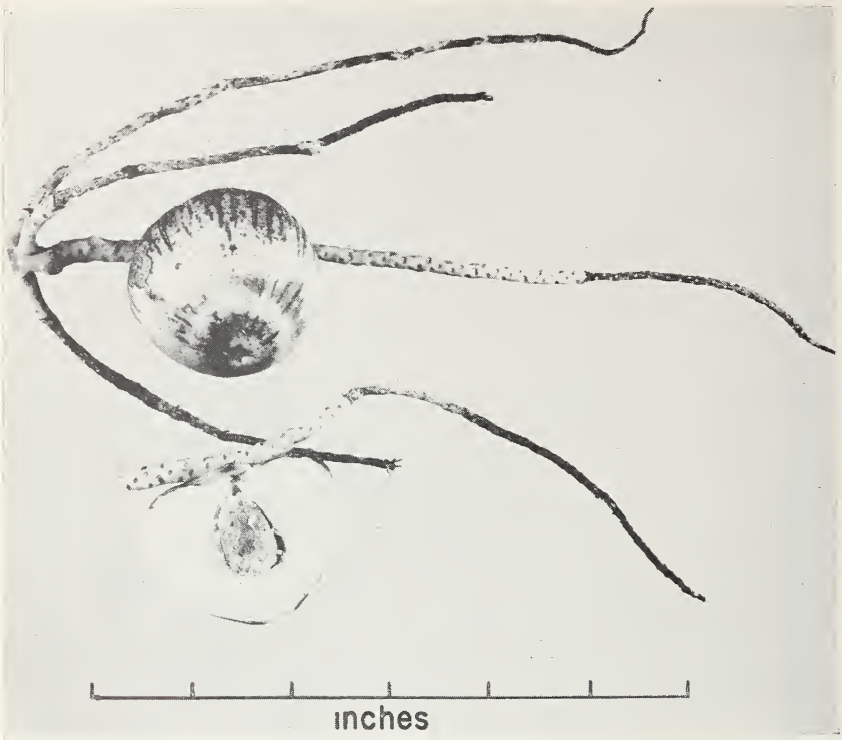

FIGURE 52.—Fruit of the peach palm, *Guilielma gasipaes.*

nutty flavor. The pulp may be ground into flour and made into cakes or fermented to prepare a beverage.

Propagation is by seeds or suckers from the base of old plants. The plants are best suited to low and medium elevations.

***Hibiscus sabdariffa* L.**
Roselle, Jamaica Sorrel (fig. 53)
"Viña," "Agrio de Guinea"
Malvaceae

Roselle is an annual plant from the Old World Tropics, the succulent calyces of which are used primarily for jam. It is closely related to the common garden okra, the ornamental species of *Hibiscus,* and to several fiber-producing plants. It produces the roselle fiber of commerce.

The rather stout, reddish stems attain a height of 5 to 7 feet and branch profusely before flowering. The first leaves are entire but as the plant grows, palmately 5-parted foliage develops. The side branches, which bear the flowers, produce 3-parted leaves.

The short-stemmed, yellow flowers, each with a red eye-zone, are borne along the upper branches. Like most species of *Hibiscus* the individual flowers last for only 1 day. In the West Indies flowering begins about October regardless of the date of planting. Early planting, however, results in larger, more productive bushes.

FIGURE 53.—The roselle, *Hibiscus sabdariffa.*

About 3 weeks after the onset of flowering the first fruits are ready for picking. It is the large reddish calyces surrounding the small seed pods that are used for food. Before separation, these measure about 2 inches in length and 1.2 inches in diameter. Separation of the calyces is easily accomplished by hand. An excellent reddish sauce, very similar in appearance and flavor to cranberry sauce, may be prepared from roselle. Jam and a reddish jelly may be made, also. The seed pods need not be

removed before cooking the calyces in the latter case. In the West Indies the calyces are sometimes used to color and flavor rum.

For the home garden the seeds should be sown directly in the row about May 15 each year. After germination the seedlings may be thinned to stand about 3 feet apart. For larger plantings the seeds should be sown in a protected seedbed and the seedlings transplanted 4 to 8 feet apart in rows 6 to 10 feet apart. Applications of stable manure or commercial fertilizer are beneficial. The plants are subject to injury by root-knot nematodes and should not be planted on land infested with these pests. The plants sometimes are attacked by a leaf-spot disease, which can be controlled by spray applications of fungicides.

***Inga laurina* (Sw.) Willd.**
Sackysac Inga (fig. 54)
"Guamá"
Leguminosae

Although the chief use of the Sackysac Inga is for shade and protection to plantations of coffee and cacao, the edible pulp surrounding the seeds is pleasantly flavored. In the West Indies quantities of the pods are sold each year in local markets and by street peddlers.

The tree is of medium size and has a low-branching habit. The dark-green shining leaflets are borne in 1 to 3 pairs along a midrib that is not winged. The small fragrant flowers with long white stamens are borne in spikes 5 to 6 inches long.

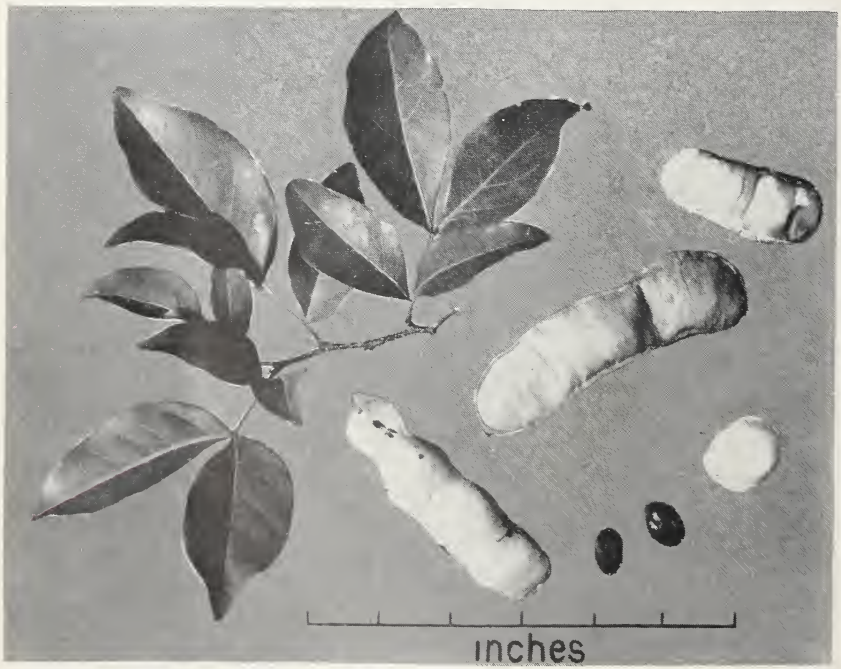

FIGURE 54.—The sackysac inga, *Inga laurina.*

Usually 2 or 3 crops of fruit are produced each year. The greenish-yellow fruits resemble plump bean pods 2 to 6 inches long and 1 inch wide. The edible portion is the sweet, white, slightly aromatic pulp surrounding the seeds.

Propagation is by seeds, which have a very short dormancy and should be planted soon after they are removed from the fruit. In the West Indies, seedlings usually can be dug from coffee plantations.

Edible fruits are produced also by several other species of *Inga*. *I. vera* Willd. differs from the preceding in having pubescent twigs and a winged leaf-rachis.

Lansium domesticum Jack.
Langsat, Lansone (fig. 55)
"Lansón"
Meliaceae

A medium-sized tree, the Langsat is widely distributed and cultivated throughout Malaysia and particularly in the Malay Peninsula for its edible fruit. The tree bears leaves a foot or more long, which are divided into 5 to 9 stalked, alternate, leathery leaflets, each 4 to 10 inches long and 2 to 4 inches wide.

Tiny yellow flowers are borne on long, solitary or clustered spikes that develop from the older branches or sometimes from the main trunk. The fruit clusters resemble bunches of large buff-colored grapes. The individual fruits are globular to ovoid and measure from 1 to 1.75 inches in the longest dimension. They

FIGURE 55.—The langsat, *Lansium domesticum*.

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have a thin, tough, milky rind. A sweet, transparent, juicy pulp surrounds the 2 to 5 green seeds in each fruit. Seedless fruits are sometimes produced. The fruit is eaten raw or may be preserved after removing the skin. The bitter seed is used medicinally in Malaysia (*13*). Fruiting occurs in September and October in Puerto Rico.

The langsat is raised from the short-lived seeds, but it is of slow growth and may require 15 years to bear. It can be budded, and this method could be used to propagate superior forms. The trees seem to grow best on good, low-lying soils.

Lecythis elliptica Kunth (fig. 56)
Lecythidaceae

Although not a well-known tree, *Lecythis elliptica* deserves to be more widely planted. It is a highly ornamental, small tree, which often begins to fruit when only about 6 feet tall. The lanceolate-oblong leaves may reach 6 to 10 inches in length. Attractive white flowers are borne in stout terminal spikes above the foliage. Each flower consists of six petals and a staminal disk that is enlarged on one side and curved over the pistil.

FIGURE 56.—Foliage, flowers, and fruits of *Lecythis elliptica.*

The grayish-brown, globose, woody capsules measure about 3 inches in diameter and contain about 8 nuts each. The capsule remains attached to the tree for some time after dehiscence of the lid, while the nuts gradually dry and fall to the ground. The nuts are about 1.25 inches in length, chestnut brown marked with yellowish anastomosing lines. They have a delicious flavor and a high oil content.

The trees are easily propagated from seeds.

***Lecythis zabucajo* Aubl.**
Paradise Nut, Sapucaia Nut, Monkey Pot (fig. 57)
"Nuez de Paraíso"
Lecythidaceae

A large forest tree from Brazil and Guiana, the Paradise Nut produces an edible nut similar to but superior to the Brazil nut. The tree bears a dense crown of elliptical leaves each about 6 inches in length. The leaves are shed toward the end of the dry

FIGURE 57.—The paradise nut, *Lecythis zabucajo*.

season but are soon replaced by a new crop of reddish-green foliage. The white flowers are borne in terminal racemes but often are not noticed until the fallen petals are seen on the ground.

The irregular-oblong ridged nuts, about 2 inches long, are enclosed in a heavy grayish-brown, woody fruit 8 inches long and 10 inches wide. Unlike the Brazil nut the fruit of the paradise nut has a large lid, which becomes detached when the fruit matures leaving the nuts dangling inside by a slender, fleshy funiculus. When this structure rots or dries, it breaks and the nuts fall to the ground. Some nuts are collected from wild trees for sale, but most are eaten by wild animals.

The nut has an excellent flavor and is considered by some individuals to be the finest nut known. Although the brown shell bears several parallel ridges, it is less sharply angled than in the Brazil nut. The shell is also softer than that of the Brazil nut.

The empty fruits have been baited with sugar and used to trap monkeys, which cannot withdraw their heads when inserted.

The trees are usually propagated by seeds and are a little slow to come into bearing. Some grafting technique probably could be employed after individual trees of superior bearing habit had been selected.

The Brazil nut (*Bertholletia excelsa* Humb. and Bonpl.) is a very large tree of the Amazon region. Although it is rather commonly seen in tropical botanical gardens it is nowhere cultivated for commercial production of the nuts. The Brazil nuts of commerce continue to be collected from wild stands. It has alternate, short-petioled, oblong, leathery leaves 8 to 20 inches long. The flowers resemble those of the paradise nut. From 12 to 24 angular, hard-shelled nuts are borne in the globose, 6-inch, woody fruit. Propagation is by seeds, and 15 to 25 years are required for fruiting.

Lucuma nervosa A. DC.
Canistel, Egg Fruit, Ti-Es (fig. 58)
"Huevo Vegetal"
Sapotaceae

The Canistel, an attractive, small tree 15 to 25 feet high, is native to northern South America. It bears glossy, green leaves 4 to 8 inches long, and pointed, globose or ovoid fruits 2 to 5 inches in length. The fruit is orange-yellow and has a mass of mealy, orange-colored, sweet pulp surrounding 1 to 3 dark-brown shiny seeds. There is considerable variation in the size, shape, and flavor of fruit from different trees and from different areas. Individual trees differ also in time of ripening so that fruit may be available from August to February.

The canistel is usually eaten out of hand, but it may be used in salads with other fruits or served with lime juice or cream and sugar. The pulp may be used in pies, puddings, jams, or ice cream.

The trees are usually propagated from seeds, but cleft-grafting or budding of superior varieties is sometimes practiced. When the patch-bud method is employed, the cut on the stock should be wiped free of latex before the bud is set in place.

A related species, *Lucuma multiflora* A. DC., is native from Puerto Rico and the Virgin Islands to Trinidad. The "Jácana," as it is called in Puerto Rico, is a tall tree. Small white flowers, which mature into ovoid, 1-seeded fruits 1.5 to 2 inches in diameter, are produced among the leaves. A thin layer of edible pulp, resembling that of the canistel, surrounds the large seed. This species usually is propagated by short-lived seeds, which germinate within 4 to 5 weeks after planting.

FIGURE 58.—Foliage and immature fruits of the egg fruit, *Lucuma nervosa*.

***Macadamia* spp.**
Macadamia, Queensland Nut (fig. 59)
"Nuez de Australia"
Proteaceae

Two very similar botanical species are called Macadamia: *Macadamia ternifolia* F. Muell. and *M. tetraphylla* L. Johnson (fig. 59). The former is called the "smooth-shell type," and the latter the "rough-shell type." Both species are large evergreen trees native to the coastal rain forests of central-eastern Australia. In its native habitat the macadamia may grow to a height of 50 to 60 feet, but elsewhere it rarely exceeds 30 feet. The leathery leaves are up to 20 inches long; those of *M. ternifolia* serrate with many spines along the edges, whereas those of *M. tetraphylla* tend to be shorter and have few prickly teeth or none. The small petalless flowers are borne in groups of 3 or 4 along a long axis and form a long narrow inflorescence with as many as 300 to 500 flowers in one raceme. The flowers are creamy white on *M. ternifolia* and pink on *M. tetraphylla* trees. The fruit consists of a fleshy husk enclosing a spherical seed 0.5 to 1 inch in diameter with a hard, brown shell. Occasionally the husk may contain two hemispherical seeds. The nuts of the *ternifolia* type are globose, glossy, and smooth; those of the *tetraphylla* type are ovoid to ellipsoid, glossy, and rough. The shell is tough and fibrous and is difficult to crack. The kernels are one of the most delicious nuts whether eaten raw or after cooking in oil. The kernels have a very high energy value, averaging 9.3 percent of protein, 78.2 percent of fat, and 8.0 percent of carbohydrates.

Culture of the macadamia has developed mainly in Hawaii, where plantings increased from 667 acres in 1943 to 3,060 acres in 1958. Seven varieties have been named in Hawaii, all of the

FIGURE 59.—The rough-shell macadamia, *Macadamia tetraphylla.*

ternifolia type, which is preferred for processing, and investigations in all phases of macadamia culture and processing are being carried on (*29*).

The macadamia, which comes into bearing in 5 to 7 years, can be propagated by cuttings, marcotts, and side-tongue grafts. Propagation by seeds is not difficult, but the resulting seedlings are variable in production and nut characteristics. Freshly harvested nuts are best used but require 30 to 90 or more days before germinating. The macadamia tree seems adapted to many kinds of soil; it fails to grow only on extremely poor types. It also is fairly drought resistant after it has become well established. To date, the macadamia is not affected by insect pests or diseases to an extent warranting control measures. It is reported to be highly resistant, and perhaps immune, to root-rot, and thus may be used as a replacement in California avocado orchards where trees have died of that disease (*17*). Young trees require pruning to develop proper structure, thus avoiding multiple leaders and ascending lateral branches with sharp-angled, weak crotches (*68*).

The macadamia not only has great potential as a commercial crop in the Tropics but also makes an excellent dooryard tree. The highly nutritious nuts make an excellent addition to the diet.

Malacantha warneckeana Engl.
Sapotaceae

This large shrub to small tree is native to the Gold Coast of Africa (*64*). It is characterized by the 3- to 7-inch, alternate, obovate leaves, which are borne at the tips of the stiff scurfy branches. At the onset of the dry season the foliage begins to fall from the plant. Many short-stemmed, greenish-white flowers are produced from April to June along the smaller branches. The reddish fruits, similar to coffee berries, ripen in 2 to 3 months. These berries vary from 0.25 to 0.50 inch in diameter and contain a single large seed surrounded by sweet, yellow pulp, which is very refreshing.

Propagation is by seeds and by air layering. Seedlings begin bearing when 2 to 3 years old if grown under favorable conditions. The plant can be transplanted readily, even when a mature tree, and is adapted to a wide range of soil types.

Malpighia punicifolia L.[4]
West Indian Cherry, Barbados Cherry (fig. 60)
"Acerola," "Cereza Colorada"
Malpighiaceae

The West Indian Cherry is one minor fruit that suddenly has assumed a more prominent position in horticulture because of the discovery that it is one of the richest, if not the richest, edible fruit sources of ascorbic acid (*6*). It was found to contain from 1,000 to 3,300 mg. of ascorbic acid per 100 gm. of edible matter. The content was highest in unripe fruit. As a result of this discovery sizable plantings have been made in Puerto Rico (*47*). The produce is marketed in the form of juice.

[4] *Malpighia punicifolia* L. has been confused with *M. glabra* L. in recent botanical literature. The plants cultivated in Puerto Rico, however, seem to correspond more closely to description of the former species as given by Britton and Wilson (*12*).

This fruit should not be confused with the Surinam cherry (*Eugenia uniflora*), which it resembles. The West Indian cherry is a shrub or small bushy tree, which may reach 20 feet in height. The shiny ovate leaves are 1 to 3 inches in length. The pink flowers, 0.5 inch in diameter, are borne profusely along the young branches toward the end of the dry season. The bright red, juicy, cherrylike fruits are somewhat obscurely 3-lobed. Each fruit contains 3 triangular, ridged seeds. A second crop usually follows the first in about 2 months, and a third crop may be produced under favorable conditions.

The fruits are usually too acid to be eaten raw, but excellent preserves or jelly can be made from them. The Florida Sweet is reported to be semisweet in flavor and to lack the characteristic tartness of most West Indian cherries (*37*). Commercially the

FIGURE 60.—The West Indian cherry, *Malpighia punicifolia.*

juice is in demand to enrich other fruit juices low in vitamin C. Processing does not appreciably decrease the content of this important constituent.

Propagation is by seeds, which should be planted within a few days after removal from the fruit. Like most of the fruits described in this publication, seedlings of the West Indian cherry are extremely variable in size of fruit, flavor, and productivity. Superior varieties can be propagated by cuttings or air layering. The plants may be grown in either clay or sandy soil, but sandy soil should be avoided where the root-knot nematode is present, as the plants are susceptible to this pest.

Mammea americana L.
Mamey Apple (fig. 61)
"Mamey"
Guttiferae

The Mamey Apple, a handsome evergreen tree 30 to 60 feet tall, is native to tropical America and the West Indies. It bears a dense crown of large, shining leaves and fragrant, white flowers 2 inches in diameter. The flowers may be perfect, or male and female flowers may be borne separately on the same or on different trees.

The fruit is ovoid, 3 to 8 inches in diameter, often with a beaked tip. The rough brown skin encloses the orange, apricot-flavored pulp in which are embedded 1 to 4 large seeds. Except for the fruit pulp, all parts of the plant exude a bitter yellow resin when cut. The pulp is eaten raw, in pies, preserves, or as sugary fruit pastes. Although the fruit is rather widely eaten, it is recommended that only moderate amounts be consumed. Investigations (*44*) have indicated that all parts of the plant contain a principle

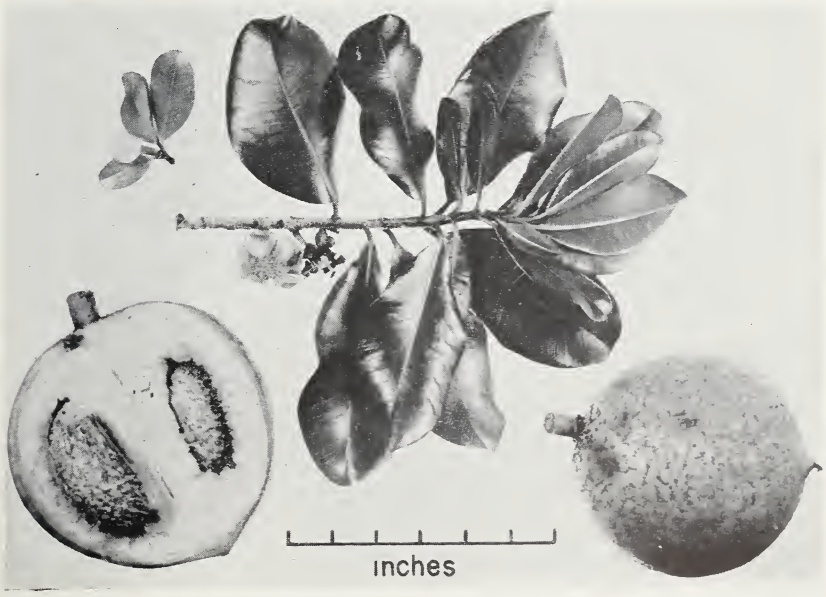

FIGURE 61.—The mamey apple, *Mammea americana*.

that is toxic to guinea pigs. The seeds and gum from the tree are used as insecticides, and the leaves are often wrapped around tomato seedlings during transplanting to ward off attack by cutworms and other pests.

The mamey apple is propagated by seeds.

***Melicocca bijuga* L.**
Spanish Lime, Genip (fig. 62)
"Quenepa," "Mamoncillo"
Sapindaceae

This tropical American tree is widely cultivated in the West Indies for its fruit. It is a medium-sized to large tree and is often

FIGURE 62.—The Spanish lime, *Melicocca bijuga*.

planted along roadsides. The small, greenish-white, fragrant flowers are borne in panicles from the branch tips at the beginning of the rainy season. The trees generally are polygamous, that is, they produce both bisexual flowers and those of one sex only. The anthers of many bisexual flowers are nonfunctional so that fruits do not develop unless cross-pollination occurs. In addition, nonfruiting trees bearing only male flowers have been found in Puerto Rico. Care should be taken, therefore, to set out plants with flowers of each sex. In Puerto Rico the fruit ripens from July to September, appearing like bunches of large, green grapes. These are cut and peddled widely along roadsides and streets.

The ovoid fruit measures a little over 1 inch in length, but an occasional tree bears fruit twice this size. Inside the tight, thin skin, which is easily cracked by the teeth, lies a thin layer of sweet-tart, yellow pulp surrounding a large ovoid seed. This pulp is a good source of iron. The seeds are said by Neal (*53*) to be edible after roasting.

Propagation is by seeds, but selected varieties can be propagated by approach grafting.

Monstera deliciosa Liebm.
Monstera, Ceriman (fig. 63)
"Piñanona"
Araceae

This Central American plant has been more widely cultivated as an ornamental than as a fruit plant, but its edible qualities are well known.

Monstera is a vigorous, creeping or climbing vine with thick stems and heart-shaped leaves often 2 feet wide and 3 feet long. The leaves are both deeply lobed and perforated near the center. The flowers, which are like huge arum lilies, appear on short thick stems during the summer rainy season. The central spadix develops into a cylindrical dark-green fruit 8 to 10 inches long and 2 to 3 inches in diameter.

The fruits are edible when fully ripe. At this time the hexagonal plates, which compose the outer rind, become yellowish and fall easily. The creamy-white, soft pulp is said to resemble a mixture of banana and pineapple in flavor. Unless fully ripe it may contain crystals of calcium oxalate, which are extremely irritating to the throat. Even ripening may be encouraged by placing the freshly cut fruit in a refrigerator for 24 hours and then leaving it at room temperature until soft.

The monstera may be propagated by seeds, but seedlings are slow in development. Tip cuttings are more rapid, and these may be set in the permanent location during the rainy season. Where a number of plants are desired, the vine may be divided into 1-foot sections, which are pressed halfway into the surface of a bed of mixed leafmold and sand. When the sprouts have developed roots they may be transplanted to the permanent location.

Morus alba L.
White Mulberry
"Morera"
Moraceae

The White Mulberry, supposedly a native of China, is cultivated to some extent in Puerto Rico where it was introduced at one time

FIGURE 63.—Flower and fruit of the monstera, *Monstera deliciosa*, taken against the background of part of a leaf.

as food for silkworms. It is a medium-sized, spreading tree with light-green, irregularly lobed leaves 2 to 4 inches long. The branches are gray or grayish-yellow.

The sweet-tasting fruits are white, pink, purple, or black,

according to the variety. Since male and female flowers usually are borne on separate trees, it is necessary to plant trees of both types. The narrow fruits measure about 1 inch in length and suggest a blackberry in external appearance. The fruits are edible raw or cooked and are made into pies or jam. The fruits are avidly eaten by birds, which sometimes make it difficult to collect sufficient for home use.

Mulberries may be propagated by seeds, but cuttings root easily and this is the more common method. The mulberry grows well on a wide range of soil types and withstands drought once it is well established.

***Muntingia calabura* L.**
Panama Berry, Capulin (fig. 64)
Tiliaceae

The Panama Berry is a small to medium-sized tree native to tropical America. The spreading branches bear 3- to 5-inch oblong leaves, which are glandular pubescent and have toothed edges.

FIGURE 64.—The Panama berry, *Muntingia calabura*.

The attractive white flowers are soon followed by quantities of the globose fruits, which are yellow or red according to the variety. The fruits, about 0.5 inch in diameter, contain a sweet, juicy pulp and many small seeds. They are eaten fresh or made into jam.

The tree is easily propagated by seeds and comes into bearing the second year. The trees require considerable pruning to prevent breakage of the quick-growing branches and to encourage fruit production.

***Myrciaria cauliflora* Berg.**
"Jaboticaba" (fig. 65)
Myrtaceae

This small bushy tree from Brazil is not well known in other tropical areas. It is a slow-growing evergreen tree with opposite, lanceolate, leathery leaves less than 2 inches in length.

The small white flowers are produced in clusters along the central trunk and larger branches. About 1 month after flowering the purplish-black fruits ripen. In both appearance and flavor they resemble grapes. The tough skin surrounds a soft, juicy, subacid-flavored pulp, which is very slightly aromatic. Embedded in the pulp is usually a single small seed. The first crop is produced in the spring and is followed by 2 or 3 lighter crops at about monthly intervals. The fruit is eaten fresh or made into jelly.

The plants are propagated by seeds, which germinate about a month from sowing. Growth of the seedlings is slow, and plants require about 10 years to bear. In Brazil superior varieties are propagated by inarching.

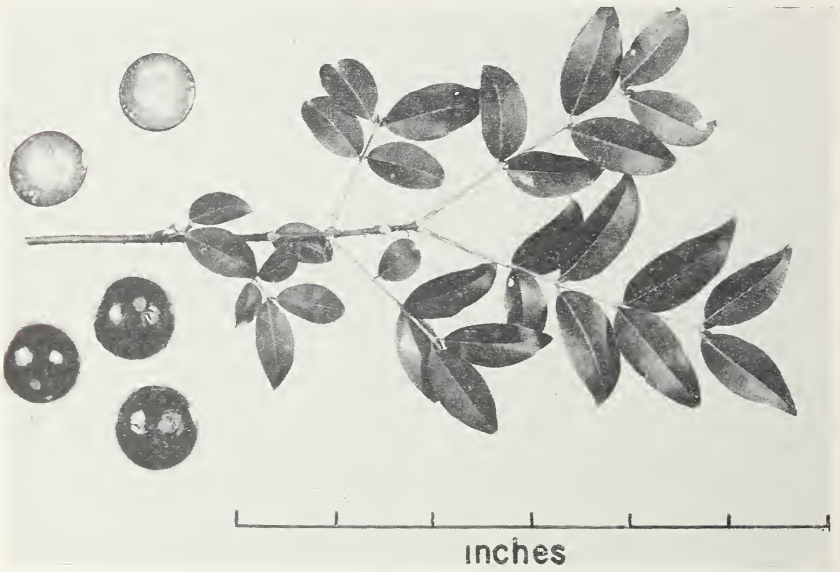

FIGURE 65.—The "jaboticaba," *Myrciaria cauliflora.*

***Myristica fragrans* Houtt.**
Nutmeg (fig. 66)
"Nuez Moscada"
Myristicaceae

Although the Nutmeg is cultivated primarily as a source of the spices, nutmeg and mace, it is valued in some tropical areas for the fruit. Native to the Moluccas, the nutmeg is a medium-sized to large tree, sometimes reaching more than 60 feet in height. It bears alternate, evergreen leaves 2 to 5 inches in length and small flowers, which are inconspicuous among the foliage. At maturity the pale-amber fruits, which resemble large apricots, split open

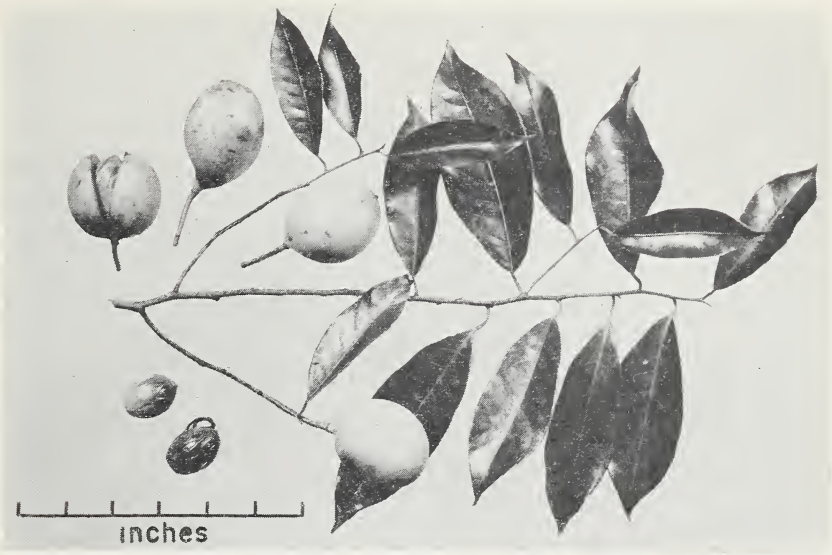

FIGURE 66.—The nutmeg, *Myristica fragrans.*

and release the glossy dark-brown nuts, which are partly covered by lacy red arils. When dried, the nut is the nutmeg of commerce and the aril is mace.

The thick fleshy husks are usable in various ways. An excellent nutmeg-flavored jelly can be made, or they can be sliced for preserves. In Malaya the half-ripe fruits are made into a candy. Seeds from many species of the genus *Myristica* have been reported to contain large amounts of resinous matter and unsaponifiables, many of which are crystalline. The antioxidant properties of some phenolic substances derived from the seeds of some *Myristica* species may have commercial value. Antioxidants are widely used to prevent spoilage of fats, particularly those intended for edible purposes.

Propagation is usually by seeds, which require about 3 months to germinate. When the seedlings are about 12 inches high they may be transferred to the permanent location. Shading is important for the first few years. Since the male and female flowers are usually borne on separate trees it is advisable to plant several in a group.

Nephelium lappaceum L.
Rambutan
Sapindaceae

This native of Malaya is a large, handsome, spreading tree with compound leaves. Large clusters of edible, red or orange-yellow fruits are borne at the tips of the branches in the summer months. The ovoid fruits are about the size of a hen's egg, and have long, soft, fleshy spines covering the surface. The edible portion is the layer of white, melting, subacid pulp that surrounds the rather large seed. In some varieties the pulp is attached to the seed, in others it is free.

The rambutan is the most promising of several related fruits for the low, humid part of the American Tropics.

The Pulasan (*Nephelium mutabile* Blume) differs from the rambutan in that the leaves are gray on the under surface, and the fruits are larger and purple brown.

The Lychee (*Litchi chinensis* Sonn.), from southern China, is a smaller tree with glossy compound leaves. The red warty fruits are about 1.5 inches in diameter and contain a layer of translucent white pulp that has an agreeable, sweet-acid flavor. Existing seedling trees in the American Tropics have been notably slow to fruit. Perhaps when grafted plants of dependable bearing varieties are available, this fruit can be more thoroughly tested. It is somewhat subtropical in its climatic requirements and should be grown at the higher elevations in the Tropics.

Another fruit from China with considerable resemblance to the lychee is the Longan (*Euphoria longan* (Lour.) Steud.). It is more vigorous in growth than the lychee, has larger leaves and brownish, wooly twigs. The reddish fruit is 0.5 to 0.75 inch in diameter and has a thin layer of edible pulp surrounding the seed. The flavor is inferior to that of the lychee.

All these related species are easily propagated by seeds, air layers, or grafting. Since seedlings of most of them are slow to come into bearing, this method can be recommended only to obtain stocks for grafting. Air layers from proved clones are sure to produce satisfactory results.

Parmentiera edulis DC.
"Cuachilote" (fig. 67)
Bignoniaceae

This tree of Mexico and Guatemala seldom grows more than 30 feet in height. The tree is adapted to a wide range of climatic conditions but is most frequently found in high-rainfall forests where it grows spontaneously, sometimes covering very large areas. Its trifoliate leaves with winged petioles are clustered at the nodes of the spiny branches. Rather large, greenish-white flowers are borne singly or in clusters at the branch tips. The ridged, red-stained, yellow fruits are 4 to 6 inches in length and 1 to 2 inches in diameter. They are sweet and edible either raw or cooked. The fruit is sometimes made into pickles or preserves. It is reported to be a good remedy for colds, and the roots are used as a diuretic (*67*). In flavor the raw fruit resembles sugarcane.

Propagation is easily accomplished by planting the small seeds.

Passiflora edulis var. *flavicarpa* Degener
Yellow Passion Fruit (fig. 68)
"Parcha"
Passifloraceae

The Yellow Passion Fruit is one of several species of the genus —all woody, perennial vines native to the tropical Americas— that produce edible fruits. It is a fast-growing vine and is also suitable for ornamental screening purposes. The alternate curly leaves are deeply 3-lobed, and the vines climb readily by means of long tendrils in each leaf axil. The white flowers are 2 to 3 inches in diameter and are characterized by long, white, or white and purple, filament-like rays. The fruits are globose to ellipsoid,

FIGURE 67.—The "cuachilote," *Parmentiera edulis.*

attain a diameter of about 2 inches, and turn from green to yellow at maturity. The interior of the brittle-shelled fruit is filled with many small seeds surrounded by a yellowish, gelatinous, aromatic pulp and juice, which is used for flavoring sherbets and for making jams and jellies. The pulp also is eaten directly from the shell with a spoon after a little sugar has been added. The most popular use is in a refreshing drink prepared by blending the fruit pulp with ice, water, sugar, and a pinch of bicarbonate of soda. The juice is an excellent source of vitamin C.

Plants of the yellow passion fruit grow well in a wide range of soils, but grow best on fertile well-drained types. The vines, which should be trained on a wire trellis or fence, produce flowers the second year after planting and set fruit continuously from June to November. Studies in Hawaii (*3*) have shown that the insect most effective in pollen transfer is the large, black carpenter bee (*Xylocopa varipuncta*). Several species of this bee are found in the Tropics; their presence as pollinating agents should be encouraged. The vines produce for many years, require little attention other than occasional pruning and fertilizing, and are not affected by any serious diseases or insect pests.

The yellow passion fruit usually is propagated by seeds, which may be planted immediately after removal from the mature fruit. Seeds should be used from vines that have consistently produced a desirable type of fruit. Germination usually occurs in 2 to 6

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FIGURE 68.—The yellow passion fruit, *Passiflora edulis* var. *flavicarpa*.

weeks. Improved strains can be propagated vegetatively by 3-node cuttings of mature wood.

The yellow passion fruit is an excellent home fruit and offers great possibilities for commercialization in the American Tropics.

The Purple Passion Fruit (*Passiflora edulis* Sims) is extensively cultivated in Australia, New Zealand, South Africa, and the Levant. It has a flavor superior to that of the yellow type but has not grown well at Mayaguez due to a wilt disease, probably caused by a species of *Fusarium*, which kills the plants.

***Passiflora quadrangularis* L.**
Giant Granadilla (fig. 69)
"Granadilla"
Passifloraceae

The Giant Granadilla forms a larger leaf and is a more vigorous grower than the yellow passion fruit. The cordate leaves are 5 to 7 inches long and arranged alternately on the stem. This plant derives its botanical name from the fact that the stems are quadrangular in cross section. The flowers are 5 inches in diameter but hang down so that the red petals and the purple and white rays are not as showy as those of some other *Passiflora* species. Fruit of the giant granadilla reach a length of up to 12 inches and turn yellow when mature. The pulp around the seeds is used

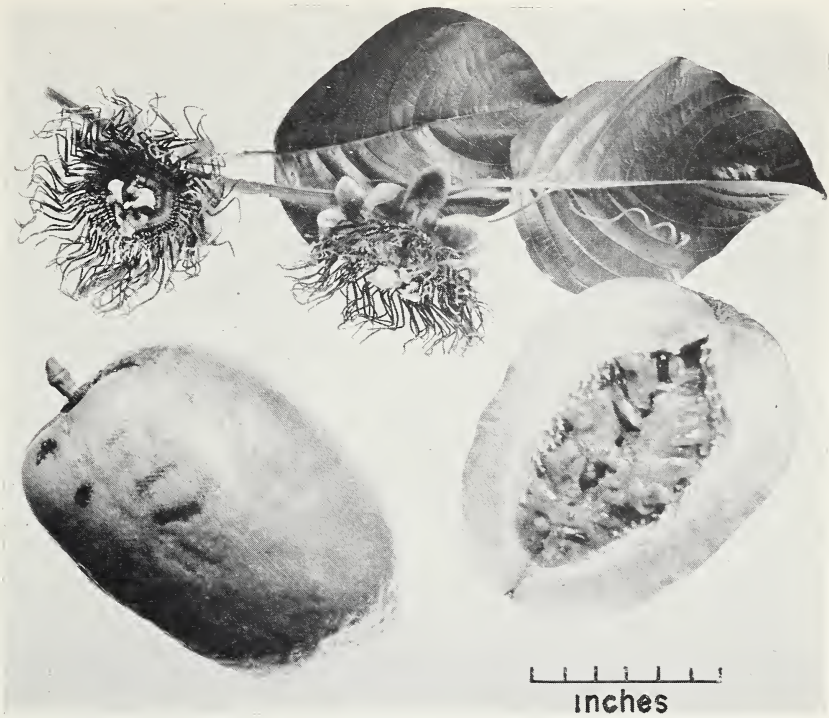

FIGURE 69.—The giant granadilla, *Passiflora guadrangularis.*

to flavor ice cream and to make a cooling drink. In addition, the flesh of this fruit is edible. The green fruit is boiled and eaten as a vegetable. The fully ripe flesh is eaten alone or in combination with such fruits as papaya and pineapple.

The flowers usually need to be hand-pollinated to effect fertilization, and the ripening fruits should be protected with wire-cloth enclosures as they are a favorite food of rats, birds, and bats.

As with the yellow passion fruit, the giant granadilla usually is propagated by seeds but can be propagated by cuttings from well-matured vines.

Several other species of the genus produce edible fruits. The Sweet Granadilla (*Passiflora ligularis* Juss.) is extensively used in the mountainous regions of Mexico and Central America. The hard-shelled, ovoid or ellipsoid fruits are slightly larger than those of the yellow passion fruit and usually are orange to orange-brown when mature. The whitish, aromatic pulp surrounding the numerous seeds is used in the same manner as that of the yellow passion fruit.

The Jamaica Honeysuckle (*Passiflora laurifolia* L.), sometimes called the Water Lemon, produces rectangular stems as does the giant granadilla. The large, fragrant flowers are strikingly marked with white, pink, red, and violet, making the plant an attractive ornamental. The ellipsoidal-shaped fruits are 2 to 2.5 inches long and are capped by 3 large green bracts. The orange-

yellow rind is soft, and the cavity is filled with a juicy pulp surrounding the seeds.

Two very similar species—*Passiflora mollissima* (H.B.K.) Bailey, and *P. van-volxemii* Triana & Planch—are known as the Banana Passion Fruit. The former has red flowers and ripens its fruit slightly later than the pink-flowered *P. van-volxemii.* Both species produce fruits that are ellipsoid and golden yellow when mature. The aromatic pulp around the seeds is the edible portion. These species are grown to a limited extent in New Zealand, and *P. mollissima* is found in Hawaii as an escape from cul-

FIGURE 70.—Foliage, flowers, and fruit of the Barbados gooseberry, *Pereskia aculeata.*

tivation at elevations of 4,000 to 5,500 feet. Both species grow best in the mountainous regions of the Tropics and should be tried where the more tropical passifloras do not grow well.

The diverse forms and variations in climatic adaptations of the edible passifloras indicate that controlled crosses would result in superior types adapted to a given geographical area.

Pereskia aculeata Mill.
Barbados Gooseberry, Lemon Vine (fig. 70)
"Hortensia de Bejuco"
Cactaceae

This tropical American shrub ultimately develops long, clambering canes, which may be 10 to 20 feet long. It bears clusters of straight spines along the lower stems and two short, curved thorns at the base of each leaf.

The smooth, glossy, thick leaves 1 to 3 inches long are edible as cooked greens. Clusters of slightly malodorous white, yellow, or pink flowers are borne at the cane tips and on short lateral branches. Individual flowers measure about 1.5 inches in diameter. The ovary is thickly set with slender green bracts that persist until the fruit starts to ripen. The 0.5-inch, juicy, acid fruit becomes smooth and yellow at maturity. It can be made into preserves for the table.

The plants are easily propagated by cuttings but may be grown from seeds.

Phyllanthus acidus (L.) Skeels
Otaheite Gooseberry (fig. 71)
"Grosella"
Euphorbiaceae

This native of Madagascar and India is commonly planted as a roadside and garden tree in the West Indies. It is a small tree, 20 to 30 feet tall, usually with a bushy crown of foliage. The slender deciduous branches are closely set with 2- to 3-inch ovate leaves giving the appearance of pinnately compound foliage.

Flowers and fruits may be clustered at the bases of the leafy branchlets but are more commonly produced on short leafless growths from the thicker branches below the foliage. The minute flowers are red. The fruits are round, flattened, about 1 inch in diameter, and have 6 ribs and a central stone that encloses 6 flat brown seeds. At maturity the fruits are pale green or yellow.

When fully ripe the fruits have a flavor resembling gooseberries and are too acid to eat raw. Cooked with sugar they become bright red and make excellent preserves and pies. Investigations by Munsell (*49*) indicate that the otaheite gooseberry is low in vitamin C, with an ascorbic acid content of 7.54 mg. per 100 gm. of fruit pulp. It may be of some value as a natural red coloring agent in preserves made from mixed fruits.

Propagation is by seeds or cuttings.

Phyllanthus emblica L.
Emblic, Myrobalan (fig. 72)
"Nely"
Euphorbiaceae

The Emblic is a medium-sized tree from tropical Asia and the adjoining islands, where it is grown as an ornamental and for its fruits. The tree differs from the otaheite gooseberry in having

FIGURE 71.—The otaheite gooseberry, *Phyllanthus acidus.*

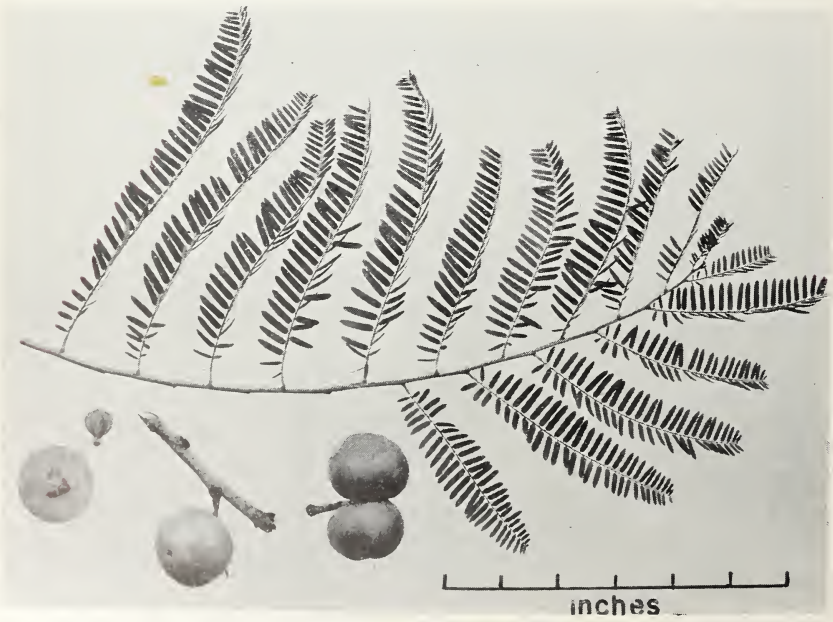

FIGURE 72.—The emblic, *Phyllanthus emblica.*

much smaller leaves crowded along the twigs in one plane. These foliated twigs give the impression of large compound leaves as found in many leguminous trees. Small yellowish flowers are borne in clusters along the branches.

The globular, pale-yellow or greenish fruits are 1 inch or more in diameter and somewhat indistinctly six-segmented. The firm, semitransparent, acid flesh surrounds a bony, 3-celled stone, which contains 6 small, brownish seeds.

In India and Ceylon the fruits are valued for preserving either at the half-ripe or fully ripe stage. Fresh fruits are used to season other foods and to flavor vinegar. Dried sections of the fruits are used extensively in Indian medicine. These and other uses are described by Morton (*45*).

The emblic is an excellent and possibly a commercial source of vitamin C. Mustard (*51*) reported 1,561 mg. of ascorbic acid per 100 gm. of mature fruit pulp.

The emblic is easily grown from seed and root sprouts, but Lynch and Fuchs (*39*) reported failure with cuttings and marcotts in Florida. Shield budding is easily accomplished and is suggested as a method of propagating clones that bear fruits high in vitamin C.

Psidium guajava L.
Guava (fig. 73)
"Guayaba"
Myrtaceae

This American fruit is well known throughout the Tropics, and in some countries it has become naturalized on wastelands. Usually, it is a low-growing tree 6 to 25 feet high, but some varieties may reach 40 feet under favorable conditions. The smooth, reddish-brown bark peels off in large flakes to reveal a smooth, gray inner bark. In dry regions the 3- to 6-inch oblong leaves are shed for a brief period each year. The fragrant white flowers, 1 inch or more across, bear numerous yellow stamens. The calyx lobes usually persist until the fruit ripens.

In shape, size, and other characteristics the fruits of the numerous varieties are extremely variable. They may be globular, ovoid, or pear-shaped and from 1 to 6 inches in length. In color, the skin may be greenish white, yellow, or brownish; the flesh, white, yellowish, or pink. In flavor, varieties range from sweet to tart, all with the characteristic musky flavor and odor of the guava more or less pronounced. Guava fruits also vary in thickness of the fleshy mesocarp, which in some forms is extremely thin. Whitman and Mauro (*75*) recently described a seedless variety with the fleshy layer so thick that almost no seed cavity remained. Most varieties bear many seeds embedded in the soft pulp of the center. Upon ripening the guava becomes soft and juicy. It may be eaten fresh or made into a juice or nectar containing fruit pulp, preserves, jam, jelly, or paste. In the West Indies pastries and desserts often contain these guava products. The guava is an excellent source of ascorbic acid (*49, 50*) with analyses varying from 25 mg. to 294 mg. per 100 gm. of fruit. It is low in riboflavin (*7*).

Numerous varieties of the guava are known, and the names of identical kinds vary from area to area. In Puerto Rico the

Dominica Red is considered best for processing although most of the fruit for this purpose comes from wild stands. The Dominica Red is highly productive, of medium size, and has pink flesh and a tart flavor. Several superior selections have been named at the Florida Subtropical Experiment Station, Homestead, Fla. (*61*).

The guava may be propagated by grafting or air layering but is commonly grown from seed. The disadvantage of the latter

FIGURE 73.—The guava, *Psidium guajava.*

method is that seedlings do not always reproduce the characteristics of the parent. Seedlings bear fruit during the second year. The guava thrives in ordinary good soil from low to medium elevations. It performs better than most fruits in poor soils.

The Strawberry Guava or Cattley Guava (*P. cattleianum* Sab.) from Brazil, is a close relative of the guava; it is more suited to the subtropics than is the guava. It is a bushy plant 10 to 20 feet high, with smooth, glossy-green, obovate leaves 1.5 to 3.5 inches long. The round purplish-red fruits seldom exceed 1.5 inches in diameter. They are of a sweet, acid flavor, somewhat resembling that of strawberries (*Fragaria* spp.). The fruit can be eaten raw or made into jam or jelly.

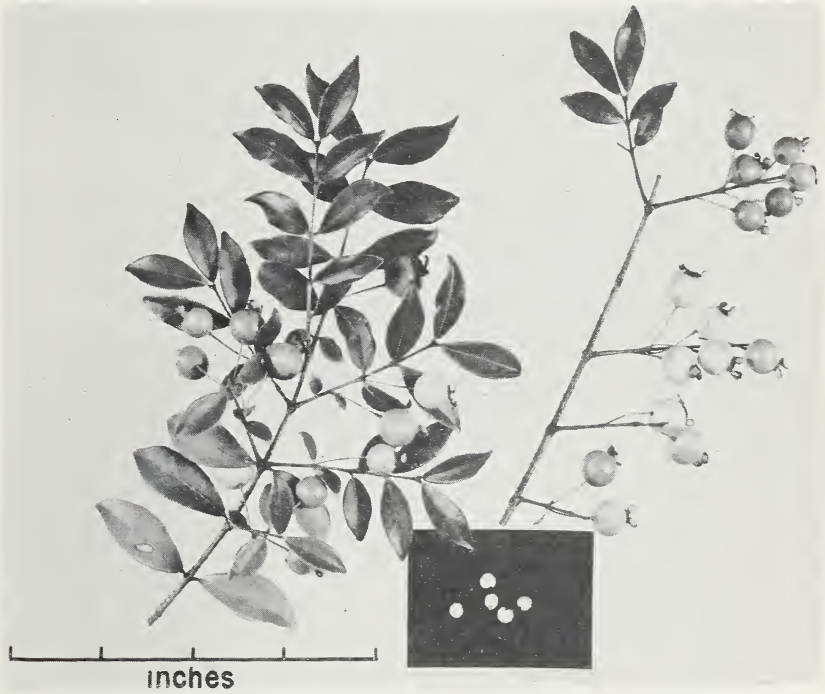

FIGURE 74.—Leaves, fruits, and seeds of *Psidium microphyllum*.

The Yellow Strawberry Guava (*P. cattleianum* f. *lucidum* Degener) greatly resembles the strawberry guava but bears slightly larger yellow fruit.

A few other species of *Psidium* are known but are not cultivated extensively. *P. guineense* Sw. is cultivated to a limited extent in Cuba. It is distinguished by the pubescent branchlets and lower surfaces of the leaves. Its fruit is similar to the guava.

Psidium microphyllum Britton (fig. 74) is sometimes encountered in Puerto Rico. Its small, aromatic, tart fruits are made into jelly. Culture of these species is similar to that of the guava.

***Punica granatum* L.**
Pomegranate (fig. 75)
"Granada"
Punicaceae

The Pomegranate originated in Southern Asia but is now common throughout the Tropics and subtropics. It was well known in the Mediterranean region in early historical times and seems well adapted to the semiarid parts of that area.

If unpruned the pomegranate develops into a tree 15 to 20 feet in height, but it is easily kept to a bush of 6 to 12 feet. In the

FIGURE 75.—The pomegranate, *Punica granatum.*

cooler parts of its range the plants are deciduous. The 2- to 4-inch, undulating, shining green leaves are tapered at both ends. Large orange-red flowers are produced early in the warm or rainy season or in humid areas several times during the year. Ornamental yellow or white flowered varieties are sometimes seen. Double flowered varieties should be avoided as they produce few fruits.

The leathery skinned, attractive red or yellow fruits vary in size from 2 to 5 inches. They are nearly globular with the notched, tubular calyx persisting. The cavity is filled with numerous seeds, each enclosed in its pink, transparent, juice sac. This juicy pulp is the edible portion of the fruit. It may be eaten out of hand or made into a cooling drink by the addition of sugar and water. The ripening season extends from midsummer to late fall. Many varieties of the pomegranate are known. One of the most popular is the Spanish Ruby.

Propagation is by seeds, cuttings, or layers. Since seedlings vary greatly, special varieties must be propagated by one of the latter methods.

***Rheedia madruno* (H.B.K.) Planch. & Triana**
"Madroño" (fig. 76)
Guttiferae

A medium-sized tree of the West Indies and tropical America, the "Madroño" is found frequently in the wet forests of Panama and southern Mexico. It bears oblong-elliptic, short-pointed, leathery leaves 4 to 6 inches long, which are dark green above and somewhat lighter green on the under surface. The cream-colored flowers are small and are clustered at the nodes of the branchlets. The fruit is globose or ovoid and 1 to 2 inches in length. It has a yellow, warty, somewhat brittle covering. The scanty, snowy-white pulp surrounding the 1 to 3 seeds has a pleasant subacid, somewhat aromatic flavor (*59*). In addition to being eaten out of hand, it is used to prepare jam. The unripe fruit is very acid. If picked before maturity, no further ripening occurs.

Propagation is by seeds. The tree is handsome and has been recommended for planting along roads and avenues.

***Rollinia mucosa* (Jacq.) Baill.**
Wild Sweet Sop, Cachiman Morveux (fig. 77)
"Anón Cimarrón"
Annonaceae

This small to medium-sized tree with slender, brown, pubescent twigs is related to the genus *Annona* from which it is distinguished by the winged petals of the flowers. In the West Indies the Wild Sweet Sop is not often cultivated, but the fruits are collected from wild plants for food.

The 6-inch leaves are oblong to elliptical, pointed at the apex and base. Yellowish flowers are borne on the twigs just below the foliage. Large fleshy protuberances cover the surface of the greenish heart-shaped fruit, which may reach a diameter of 6 inches. The flesh is sweet, soft, and viscous, edible but not highly flavored. In it are embedded numerous black seeds, 0.5 inch long.

The genus *Rollinia* contains about 50 species, all American. Some are highly prized for the fruit and are said to rival the cherimoya in flavor.

Propagation should be easily accomplished by seeds.

FIGURE 76.—Foliage, fruits, and seeds of the "madroño," *Rheedia madruno*

***Rubus albescens* Roxb.**
Mysore Raspberry or Ceylon Raspberry (fig. 78)
Rosaceae

The members of the genus *Rubus*, collectively called bramble fruits, are worldwide in their distribution. Not only are there numerous distinct species, but also many intermediate forms. The bramble fruits are divided into two broad classes: The raspberries, in which the coherent drupelets detach from the receptacle (core) at maturity, and the blackberries and dewberries in which the drupelets do not separate from the core.

FIGURE 77.—The wild sweet sop, *Rollinia mucosa*.

The species of *Rubus* commonly cultivated in temperate climates usually do not grow well in the Tropics. Many indigenous species are found in the Tropics, however, and some of these have distinct possibilities for commercialization, or as a source of desirable characteristics in breeding programs.

The Mysore Raspberry, native to the mountains of India, Ceylon, Malaya, and Indonesia, is one of the better types. The clambering canes of this plant, if left unpruned, form a mass that may reach a height of 10 to 12 feet.

FIGURE 78.—The Mysore raspberry, *Rubus albescens*.

The young canes are glaucous or have a waxy bloom and possess many sharp, recurved spines. The compound leaves have 5 to 9, usually 7, leaflets. The leaflets are cordate-acuminate and about 2 inches long. The leaflets are dark green and prominently veined on the upper surface, but have white appressed hairs on the under surface that give a silvery appearance. The purplish flowers, which are about 0.5 inch in diameter, are produced in terminal and axillary clusters on young lateral shoots near the tips of the mature canes. The fruits are up to 0.75 inch in diameter and are dark purple at maturity. The fruits are juicy and have an acid-sweet flavor. The fruits tend to remain attached to the pedicel and have a persistent calyx.

In Puerto Rico, the Mysore raspberry has grown well at elevations of 800 feet or more. It can be propagated by seeds, but germination is slow and erratic, and the seedlings exhibit great variation in fruit flavor. It can be propagated readily by means of tip layers and cuttings of mature canes.

Because of its vigor and freedom from disease in Central America, the Mysore raspberry should be used in breeding. It is reported to be the only observed raspberry that will grow well in the southern part of Florida (*36*).

Rubus florulentus Focke
"Fresa de Montaña" (fig. 79)
Rosaceae

The perennial, climbing canes of this native Puerto Rican blackberry are angled, more or less pubescent, and sometimes

FIGURE 79.—The "fresa de montañ." *Rubus florulentus.*

reach a length of 20 to 30 feet. The canes are armed with small, recurved prickles. The leaves are 3-foliolate. The leaflets are ovate to oval, about 1.5 inches wide by about 2 inches long, and finely serrated. The terminal leaflet usually is longer and broader than the lateral leaflets. All leaflets are glabrous, shiny green on the upper surface, and dull green on the lower surface. The fruits are produced on many-flowered terminal panicles, the rachis and branches of which are armed with recurved prickles that are larger and more numerous than those found on the canes. The

dark-purplish to black fruits have a pleasant acid flavor, but the seeds are so large and numerous that the fruits are not suited for eating out of hand. They can, however, be used for jams and jellies. Plants of this species grow best in the mountain regions of Puerto Rico. It is propagated by cuttings and by tip layering mature canes.

Another blackberry, which might be especially useful in a breeding program because of its immense fruits, is the Columbian blackberry, *Rubus macrocarpus* Benth (*23*). The Columbian blackberry is indigenous to the area from Central America south to Peru. The scarlet or wine-red fruits are reportedly as large as hen's eggs but are only fair in quality.

***Rubus glaucus* Benth.**
Andes Berry (fig. 80)
"Mora de Castillo"
Rosaceae

This delicious blackberry is native to the broad area from the northern Andes of South America to the highlands of southern Mexico, but it has been introduced into many other areas of the Tropics. The Andes Berry forms a vigorous shrub with canes 9 to 12 feet long, which are more or less densely covered with a white bloom. The canes are armed with small, hooked prickles.

The leaves are 3-foliolate, with lanceolate or ovate-lanceolate leaflets that are sharply, but not deeply, doubly serrated. The petioles, petiolules, and midveins of the leaflets are armed with small, recurved prickles. The leaflets are green on the upper surface and whitish-tomentose beneath. The white flowers are produced mainly in terminal racemes, but a few are produced from the leaf axils. The dark-purple, globular to ellipsoid fruits are up to 1 inch in length. The juicy fruits have an excellent flavor, slightly sweet and highly aromatic, which makes them well suited for fresh consumption and for jams and preserves. The seeds are small and soft.

The Andes berry can be propagated by seeds, but improved selections should be propagated vegetatively by tip layers. It succeeds on many types of soil, but does best on heavy soils abundantly supplied with moisture. In the Tropics, the Andes berry grows better at the higher elevations than in the coastal regions.

Another blackberry worthy of testing is the Shank's blackberry (*Rubus shankii* Standl. & L. O. Williams), which is native to Honduras. It is a small but erect-growing plant that produces large fruits of excellent quality with small, soft seeds.

***Rubus rosaefolius* Smith**
"Fresa," "Frambuesa Común," "Zarza" (fig. 81)
Rosaceae

Although native to the Himalayan region and China, this red raspberry is widely distributed in tropical countries and has become naturalized in the West Indies. In fact, in some areas it is called the West Indian raspberry. It forms somewhat erect, evergreen canes that reach a length of 3 to 4, and sometimes 6 feet. The thin canes are somewhat pubescent and are sparingly armed with small, recurved prickles. The odd-pinnately compound leaves usually have 5 or 7 leaflets, but sometimes have as many as 9 or 11. The uppermost leaves on the plant usually have only 3

FIGURE 80.—The Andes berry, *Rubus glaucus*.

leaflets and some are entire. The ovate-lanceolate leaflets are prominently veined, sharply serrated, and lightly hairy on the undersurface. The white flowers, which are up to 2 inches in diameter, are produced singly or in few-flowered clusters. The thimble-shaped fruits are about 1 inch in length and are composed of numerous small drupelets. They are bright red or reddish-orange at maturity and have very small seeds. While pleasant tasting, the fruits have very little flavor. The attractive appearance of the fruit and the small-sized seeds should make this species valuable in breeding raspberries for the Tropics. It is propagated by root suckers and root cuttings.

The botanical variety of this species, var. *coronarius* Sims, is a double-flowered form sometimes cultivated as an ornamental

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FIGURE 81.—The "fresa" red raspberry, *Rubus rosaefolius*.

plant. It is called the Bridal Rose, and in Spanish, "Rosa de Novia."

The Queensland raspberry (*Rubus probus* Bailey) also is a promising type for the Tropics. It originated in Australia and probably is a cross between *R. ellipticus* Smith and *R. rosaefolius*. The Queensland raspberry is more vigorous but less thorny than *R. rosaefolius* (*27*). The red fruits, which are produced from many-flowered clusters, are larger and of better flavor than those of *R. rosaefolius*, but crumble readily. The Queensland raspberry can be propagated vegetatively by suckers, which arise from the roots, or by root cuttings.

***Sicana odorifera* (Vell.) Naud.**
Cassabanana (fig. 82)
"Pepino," "Curuba," "Pepino Angolo"
Cucurbitaceae

This South American perennial vine occasionally is cultivated for its fragrant fruit. It is a large quick-growing vine that climbs easily into the tops of small trees and has value as an ornamental plant. The cordate, lobed leaves may reach 12 inches in diameter. Yellow flowers, which are solitary at the nodes, develop into smooth, cylindrical, orange-crimson fruits 12 to 24 inches long and 4 inches in diameter. These consist of an outer fleshy layer and a many-segmented center cavity filled with juice and black

FIGURE 82.—Fruit, flowers, and leaves of the cassabanana, *Sicana odorifera*.

seeds. The fruit is edible and has a pleasant aromatic flavor. It is made into preserves or macerated in water to give a pleasing drink. In Puerto Rico it is eaten to relieve throat disorders.

The cassabanana is easily propagated by seeds.

***Solanum quitoense* Lam.**
"Naranjilla" (fig. 83)
Solanaceae

The "Naranjilla" is native to the northern Andean region of South America. It is cultivated most extensively in Ecuador and

Colombia at elevations between 3,000 and 7,000 feet (*41*). The plant is a robust herb 6 to 10 feet high, with large ovate, dentate leaves that may measure 18 inches long. The leaves are dark green with purple veins on the upper surface and whitish or purplish on the lower surface. All parts of the plant except the upper surfaces of the leaves are wooly pubescent, and all parts are thorny except for the flowers and fruit. The 1.5-inch pale-lilac flowers are clustered in the axils of the leaves.

The globular fruits measure 1.5 to 2.5 inches in diameter at maturity. They are bright orange and are covered with short brittle hairs, which are easily removed by rubbing. Internally the fruit resembles a tomato. The pulp is green, acid, juicy, and contains many seeds slightly larger than tomato seeds. A delicious and refreshing, green-colored juice is prepared from the fruits. It is reported to be rich in vitamins, proteins, pepsin, and minerals (*41*). The fruits are also made into preserves and pies. The plants are in production every month of the year.

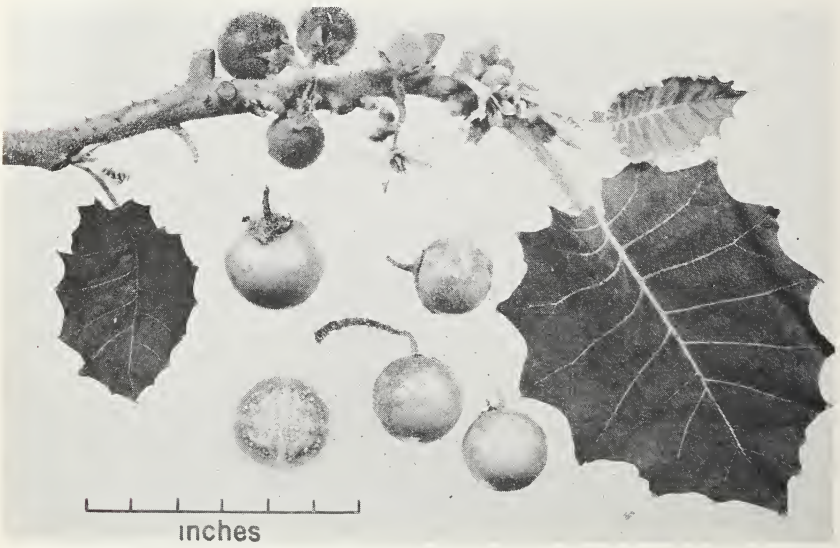

FIGURE 83.—The "naranjilla," *Solanum quitoense.*

The "naranjilla" is propagated by seeds, cuttings, or grafting. Plants begin to bear in 6 to 12 months and continue for 3 years or more (*26*). The plants are usually grown with some shade in Ecuador, where they are set in virgin forests from which the undergrowth has been cleared. In Puerto Rico an experimental planting fruited well in a cleared mountain valley at an elevation of about 3,100 feet. The plants thrive in the Andean region, where average rainfall ranges from 60 to 150 inches. No doubt they could be cultivated in many areas of the tropics having similar ecological conditions.

In southern Florida the "naranjilla" has been found to be extremely susceptible to infestation by the root-knot nematode and

plantings seldom attained fruiting size (*35*). When cleft grafted on related herbaceous plants, such as *Solanum macranthum* Dun., however, the plants survived for about 3 years and fruited successfully.

The "Cocona" (*Solanum hyporhodium* A. Br. & Bouche), from the upper Amazon area of Peru, differs from the "naranjilla" in having cream-colored pulp and no thorns (*25*). It is also larger and more acid. The fruit is made into pies, preserves, and jelly. Although little is known about the adaptability of the "cocona" to cultivation in various tropical areas, it is thought to be adaptable to lower elevations in the humid tropics.

Spondias cytherea Sonn.
(Syn. *S. dulcis* Forst. f.)
Otaheite Apple, Ambarella (fig. 84)
"Jobo de la India"
Anacardiaceae

This erect stately tree is probably the most widely cultivated species of *Spondias*. Under favorable conditions it grows to a height of 60 feet. The pinnately compound leaves clustered near the tips of the stout branches are 8 to 15 inches in length with 11 to 23 oblong leaflets about 3 inches in length. The tree is semi-deciduous. The small whitish flowers are borne in large, loose, terminal panicles.

The 2- to 3-inch fruit is globular to ovoid and often somewhat irregular in outline with indistinct ridges on the sides. From 2 to 10 fruits are borne in a cluster. The tough skin is golden yellow when ripe. A single, large, spiny seed is embedded in the firm juicy flesh, which is also yellow. The flavor of the fruit varies

FIGURE 84.—The otaheite apple, *Spondias dulcis*.

from acid to sweet. It is usually only pleasantly aromatic but may be resinous and disagreeable in some varieties. It is usually eaten fresh but may be preserved. The fruit pulp is a good source of iron and a fair source of vitamin C.

Propagation is usually by seeds, which require about 1 month to germinate. It is recommended, however, that this method be used only to produce rootstocks on which to shield-bud material from the occasional good variety. Wester (*74*) recommends that the shield buds be taken from nonpetioled, slender, mature but green and smooth budwood. As in most species of this genus, stout mature branches may be rooted. The trees are well adapted to the warm, humid tropics where they grow best on deep, rich soils.

***Spondias mombin* L.**
(Syn. *S. lutea* L.)
Hog Plum, Yellow Mombin (fig. 85)
"Jobo," "Jobo Gusanero"
Anacardiaceae

The Hog Plum is a tall, spreading tree up to 60 feet or more in height, usually with glabrous twigs and bark armed with stout prickles. The species may be native to tropical America but is known in many tropical countries.

The glabrous, pinnately compound leaves may reach 20 inches in length with oblong, asymmetrical leaflets varying from 2.5 to 5 inches in length. Small yellow fragrant flowers are borne in terminal panicles, which may be 2 feet or more in length. The fruit is oval in outline and measures 1 to 1.5 inches in length. It has a thin layer of watery pulp surrounding the rather large seed. The flavor is pleasantly subacid and pungent. A large tree will litter the ground with fruit during the ripening season, which

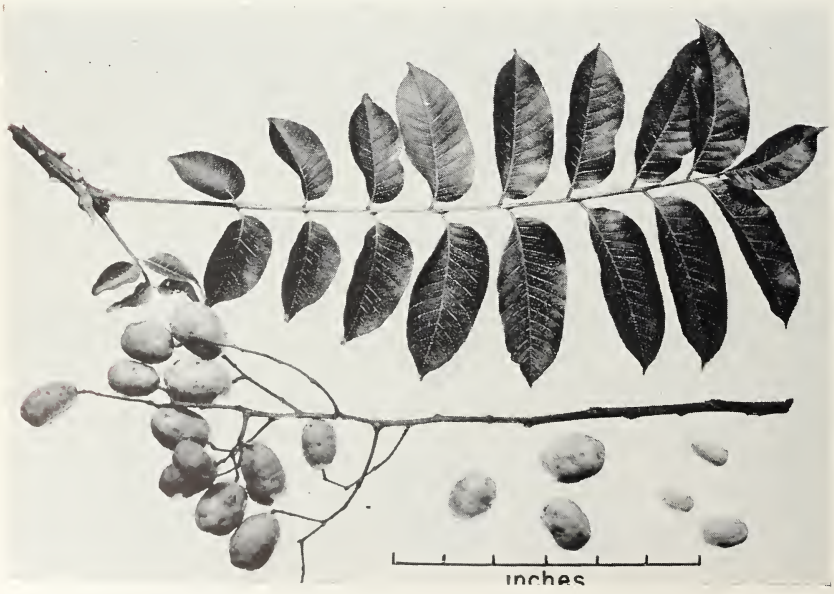

FIGURE 85.—The hog plum, *Spondias mombin.*

is during the summer rainy season. The common name, hog plum, has arisen because of the liking these animals have for the fruit. Usually the fruits are so badly infested with fruit fly larvae (*Anastrepha* spp.) that they are not fit for human food. When free of these pests they are eaten out of hand or made into jelly.

The hog plum is propagated by seeds or cuttings of mature wood. The trees grow well at low and middle elevations in a wide variety of soils.

***Spondias purpurea* L.**
(Syn. *S. mombin* Auth.)
Red Mombin, Spanish Plum, Jamaica Plum
"Jobillo," "Ciruela del País"
Anacardiaceae

The Red Mombin, a deciduous tree of tropical America, is commonly planted in Mexico and Central America and is often seen throughout the West Indies. The trees, which seldom exceed 25 feet in height, are characterized by the stout trunk and stiff branches. The pinnate leaves are 6 to 9 inches long with 17 or more thin, obliquely oblong-elliptic leaflets 0.5 to 1.5 inches in length. The reddish flowers are produced on short growths from wood of the previous season.

The deep-red fruits, which ripen in early summer, are borne singly or 2 or 3 together. They vary in shape and size but usually are oval in outline, 1 to 2 inches in length, and have a somewhat irregular surface. A layer of very juicy, subacid, aromatic pulp

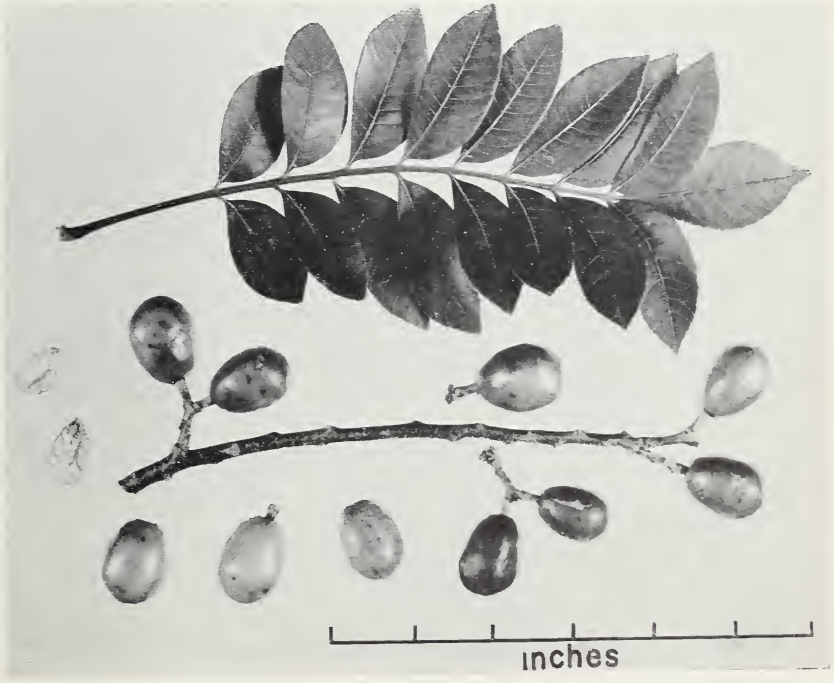

FIGURE 86.—The yellow mombin, *Spondias purpurea* var. *lutea*.

surrounds the rather large, slightly rough seed. The fruit is usually eaten fresh and is of higher quality than most of the other species.

Propagation is by seeds or by setting large woody cuttings in the desired location. Fenceposts cut from the red mombin tree usually continue to grow.

In Puerto Rico and the Virgin Islands the yellow variety, *S. purpurea* var. *lutea* Hort. (*S. cirouella* Tussac), is more commonly planted than is the red mombin. This variety (fig. 86) is known locally as "Ciruela." It differs from the red mombin in having obovate, smooth, yellow fruits that ripen from August to October. It is a larger tree with larger leaflets. The yellowish flowers are borne while the tree is dormant. The flavor is identical with that of the red mombin.

The Imbu (*S. tuberosa* Arruda) from Brazil has been introduced in other tropical areas but is not well known. It is considered by Popenoe (*58*) to be the best flavored of the *Spondias*. It is a low spreading tree with swollen roots. The leaves are smaller than in the other species and have only 5 to 9 leaflets. The 1.5-inch fruit is borne in abundance on short panicles. It is eaten raw, in jelly, or made into a custardlike dessert with milk.

***Sterculia foetida* L.**
Java Olive (fig. 87)
"Anacagüita"
Sterculiaceae

The Java Olive is a large, spreading deciduous tree from the Asiatic Tropics. The long-petioled leaves are palmately compound

FIGURE 87.—The Java olive, *Sterculia foetida*.

with 5 to 11 smooth, pointed leaflets. The red and yellow or purplish flowers, which are borne early in the rainy season, measure 0.75 inch in diameter. Because of the extremely unpleasant odor of the flowers it is recommended that this tree be planted at some distance from dwellings.

The fruit has 1 to 5 smooth, rounded, reddish carpels, each 3 to 5 inches in length. At maturity these split open to reveal 10 to 15 gunmetal-colored seeds, each about 1 inch long, arranged along the edges of the opening. The seeds are eaten raw, roasted, or fried. They are oily with a pleasant flavor. Like many nuts, they have a purgative effect if too many are eaten.

The Java olive is propagated by seeds that germinate 1 to 2 weeks after planting.

The Panama Tree (*Sterculia apetala* (Jacq.) Karst.) from Panama yields seeds that may be eaten in the same way. It differs from the Java olive in that the large leaves are lobed but not divided to the base. The fruits are lined with irritating hairs and are less colorful than those of the Java olive.

Synsepalum dulcificum (Schum.) Daniell
Miracle Fruit (fig. 88)
Sapotaceae

The Miracle Fruit was brought from Africa by the U. S. Department of Agriculture as plant introduction No. 73071. The plant is an ornamental shrub, usually many branched and with dense foliage, which attains a height of 6 feet. Several crops of the attractive red fruits are borne during the year. These are ellip-

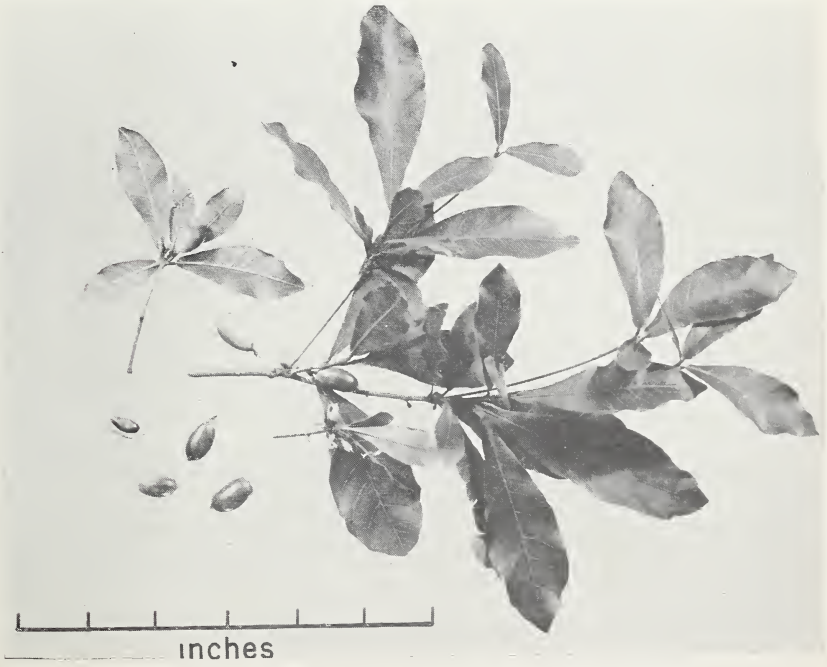

FIGURE 88.—The miracle fruit, *Synsepalum dulcificum*.

soidal, about 0.75 inch long, and have a thin layer of pulp surrounding a single, large seed.

The miracle fruit is not particularly recommended for its food value, but as a novelty it is unique. The first taste is somewhat tart but it soon changes to pleasantly sweet. Eating the fruit produces a partial ageusia so that everything eaten or drunk for about an hour afterwards tastes intensely sweet. A lime or lemon can be eaten as if it were a sweet orange. Apparently eating the fruit paralyzes the taste buds to sour or acid foods. Salty and bitter flavors are affected to a lesser extent.

Dalziel (*22*) reports that it is generally found planted near native dwellings in tropical West Africa. It is put into palm wine and is used to improve the taste of stale food.

The miracle fruit is propagated by seeds.

Syzygium cumini (L.) Skells
(Syn. *Eugenia jambolana* Lam.)
Java Plum, Jambolana Plum (fig. 89)
"Manzana Malaya"
Myrtaceae

This East Indian fruit forms a medium-sized evergreen tree bearing handsome glossy foliage. The broadly oblong, pointed leaves are 5 to 8 inches in length and have many, inconspicuous, parallel veins. The small, white, fragrant flowers are produced in axillary panicles. The shiny, dark-purple or black fruits are up to 1.5 inches in length. Each fruit contains a single, large, oblong seed surrounded by a thin layer of yellowish pulp. The pulp is juicy and acid but often has an undesirably astringent taste. The Java plum is of poorer quality than the other eugenias discussed in this publication. The pulp of the less astringent types,

FIGURE 89.—The Java plum, *Syzygium cumini.*

however, is used to make tarts, jelly, and sherbet. The astringency is sometimes removed before cooking by soaking the fruits in salt water.

The Java plum is usually propagated by seeds. It does not grow well in areas of low rainfall. In India, the Java plum is reported to thrive on poor laterite soils in sections where the rainfall is as high as 200 inches per year.

***Tamarindus indica* L.**
Tamarind (fig. 90)
"Tamarindo"
Leguminosae

The Tamarind is a slow-growing tree that eventually attains a large size. It is thought to be a native of tropical Africa that has become naturalized in many parts of the Tropics and subtropics. The trees seem particularly well adapted to semiarid regions but tolerate high rainfall if the soil is well drained.

The tree usually has an open framework, with spreading branches and graceful, feathery leaves. Each leaf bears 10 to 20 narrow leaflets about 0.5 inch long. Yellow and red flowers about 1 inch in diameter are borne in short racemes. The fruit is a straight or curved brown pod from 2 to 6 inches in length and 0.75 to 1 inch in width. Partial strictures show the approximate number of seeds contained in the fruit. At maturity the thick, dark-colored, acid pulp shrinks from the shell, which becomes very brittle. Sweet-fruited varieties are known.

Many tamarind fruits are eaten out of hand. The tree has numerous additional uses in India where it is very common. The

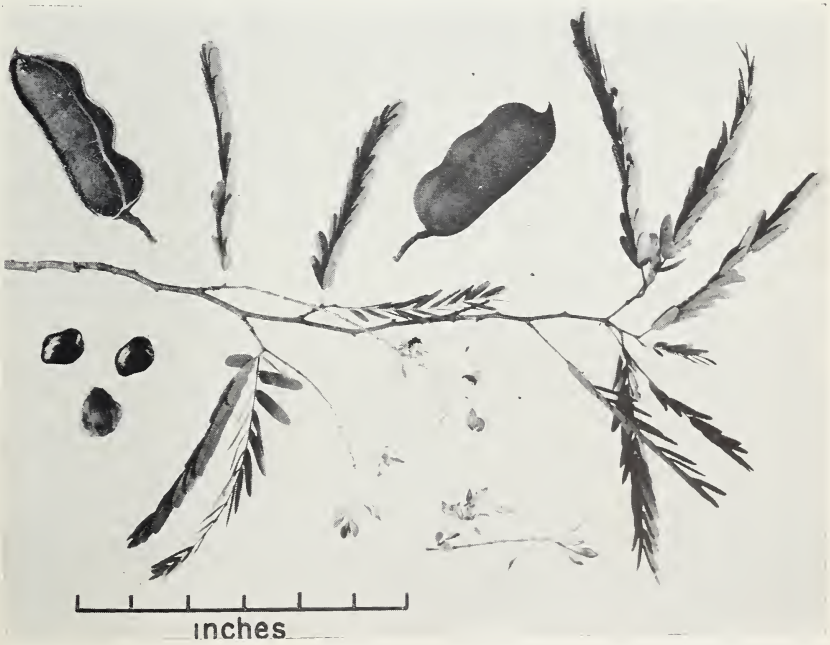

FIGURE 90.—Foliage, flowers, and fruit of the tamarind, *Tamarindus indica*.

tender leaves and flowers are eaten in curries and chutneys. The fruit pulp is widely used to prepare an acid drink and in making preserves and sauces. Dried pulp is exported from India and the West Indies for the preparation of chutneys and meat sauces in Europe and America. The thick sticky pulp contains as much as 14 percent of acid, mostly tartaric (*42*), and is said to be a good source for the preparation of the acid (*1*). At the same time the pulp may contain as much as 41 percent of sugar. It is a good source of vitamin B, calcium, and phosphorus. The seeds, formerly a waste product of the fruit-processing industry in India, are now a source of carbohydrates for sizing cloth, paper, and jute products, and a vegetable gum in the food-processing industry.

The tamarind tree usually is propagated by seeds but budding is possible.

Terminalia catappa L.
Tropical Almond (fig. 91)
"Almendra"
Combretaceae

This large spreading tree from Malaysia is now widely planted in the Tropics for ornament, shade, timber, and the edible nuts. The primary branches are usually horizontal and arranged in tiers. Secondary branchlets bear terminal rosettes of shining green, opposite-ovate leaves 6 to 12 inches in length. The old leaves become bright red before falling, a tendency especially pronounced in the dry season.

Small greenish-white, malodorous flowers are borne on slender spikes among the leaves. Two crops of fruit are borne each year and sporadic fruiting occurs between crops. The yellowish-green or reddish fruit is ovoid, compressed, pointed at both ends, and 2 inches in length. It consists of a thin fleshy pericarp, which is edible but of poor quality, a hard corky interior, and usually one slender pointed kernel. The fine-flavored kernels are edible raw or roasted, but very few of the fruits produced in the Western Hemisphere are utilized for food because of difficulty in cracking the shell. Cracking is easier after the nuts dry out, and it might be possible to devise some mechanical means of cracking and cleaning them. In the West Indies they are often cracked between stones by children.

The kernels yield an edible oil of excellent flavor. Asenjo and Goyco (*8*) obtained a yield of nearly 55 percent by extraction and 35 percent by expression.

Propagation is by seeds, which remain viable for at least 1 year. The seeds germinate in 2 to 4 weeks after planting.

Theobroma cacao L.
Cocoa (fig. 92)
"Cacao"
Sterculiaceae

The Cocoa tree is native to tropical America, where it was cultivated in pre-Columbian times. It grows 12 to 40 feet high, has pubescent branches and evergreen, leathery, oblong, pointed, short-petioled leaves about 12 inches long. The trees have a tendency to produce strong lateral suckers from the base, which eventually become supplementary trunks.

FIGURE 91.—The tropical almond, *Terminalia catappa*.

Clusters of small, short-stalked, pink and yellow flowers are borne along the trunk and larger branches several times during the year. The yellow or red fruit is ovoid to ellipsoidal in shape, 6 to 10 inches in length, and about 4 inches in diameter. It is irregular in outline and has about 10 ribs in the hard exterior. The interior is a mass of 25 to 36 seeds surrounded by white, mucilaginous, edible pulp. In flavor this pulp is subacid and sweet. It makes an excellent jelly with the addition of pectin. The inch-long seeds are the "cacao" beans of commerce from which cocoa and chocolate are made.

The cocoa tree thrives in rich, moist but well-drained soil. It

FIGURE 92.—The cocoa, *Theobroma cacao.*

is usually grown in the shade of larger trees for protection from sun and wind. Numerous named varieties are known.

The trees are propagated from seeds, cuttings, or by budding.

***Triphasia trifolia* (Burm. f.) P. Wilson**
Limeberry (fig. 93)
"Limón de Jerusalén," "Chinita"
Rutaceae

The Limeberry is a spiny shrub or small tree from tropical Asia. It bears alternate, 2-inch, short-stalked, 3-parted, dark-

green leaves on its zigzag branches. The leaflets are ovate or elliptical, and the central leaflet is larger than the lateral ones. Several flushes of the small, white, fragrant flowers are borne each year. The dull-red fruits are ovoid or globular and measure about 0.5 inch in diameter. The highly aromatic, juicy pulp contains numerous oil glands. It is made into preserves or crystallized fruit.

The plants make an excellent boundary hedge and will stand considerable pruning. They grow well in alkaline soils and near the sea and have promise as a stock for the common citrus fruits for use on such soils. In some of the West Indies the limeberry has become naturalized.

FIGURE 93.—The limeberry, *Triphasia trifolia*.

Uvaria lancifolia Merr.
"Calabao" (fig. 94)
Annonaceae

The "Calabao," a climbing shrub from the Philippine Islands, produces highly ornamental, edible fruits. Shade-grown plants produce viny stems 16 to 20 feet long, which climb by occasionally producing a loop in one of the branchlets. In more open situations the plants remain shrubby.

The young twigs and undersurfaces of the leaves are densely pubescent. Maroon-colored flowers are produced on short stems in early summer. In late summer the brilliant Chinese-red fruits ripen. From a few to many of the oblong, stalked fruits are borne in a cluster. Each fruit measures 1 to 3 inches in length and contains many seeds in 2 rows, surrounded by whitish, subacid, aromatic, fleshy pulp. They are eaten raw or made into preserves.

Propagation is by seeds.

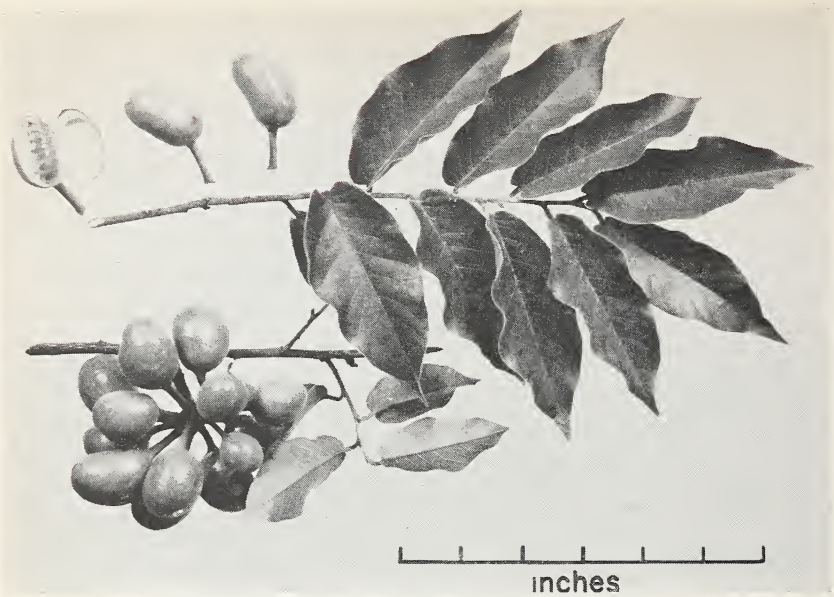

FIGURE 94.—The "calabao," *Uvaria lancifolia.*

***Vangueria edulis* Vahl.**
Spanish Tamarind, Voavanga (fig. 95)
Rubiaceae

This large, rather coarse shrub from Madagascar and Africa is rather widely distributed in the Tropics but is not generally well

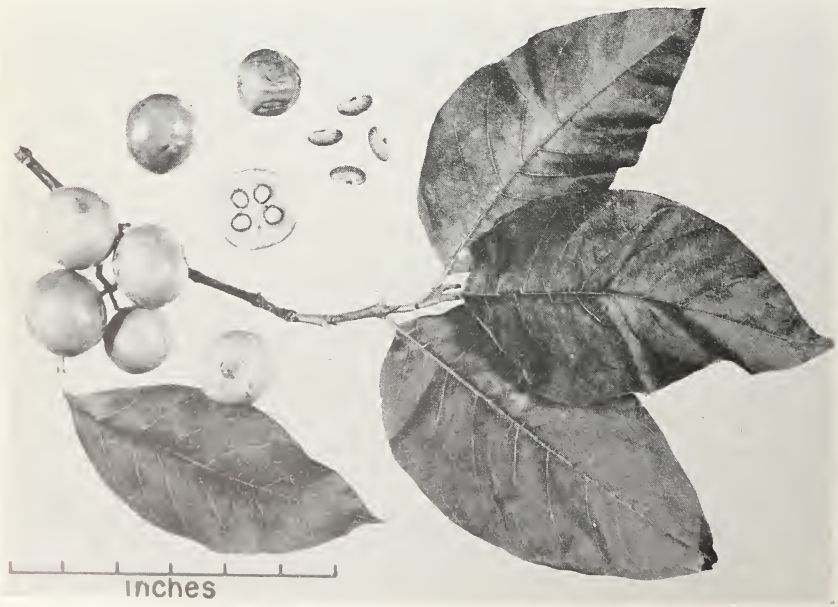

FIGURE 95.—The Spanish tamarind, *Vangueria edulis.*

known. The 3- to 8-inch shining, pale-green leaves are attached opposite each other on the branches. Small greenish-white flowers are borne in clusters in the axils of the leaves. The fruits are globose, smooth, and green with white dots. At maturity the fruit measures about 1.75 inches in diameter and contains 4 or 5 seeds each 0.75 inch long. The flavor is sweet-subacid, suggesting an unripe apple. The fruits are eaten out of hand or may be stewed. If allowed to remain on the bush after maturity, the fruit shrivels and becomes brownish in color. At this stage the flavor is suggestive of the tamarind (*Tamarindus indica*).

The plants are well suited to the humid tropics but tolerate a dry season of several months.

They are propagated by seeds or cuttings.

***Zizyphus mauritiana* Lam.**
(Syn. Z. *jujuba* Lam. not Mill.)
Indian Jujube (fig. 96)
"Aprín"
Rhamnaceae

The Indian Jujube is an evergreen shrub or tree 10 to 40 feet in height from the Asiatic Tropics. It should not be confused with the Chinese Jujube, *Z. jujuba* Mill., a tree of temperate climates.

Leaves of the Indian jujube are ovate to elliptical, rounded at the tip, and measure about 2 inches in length. The young branches and the undersurface of the leaves are densely pubescent. Single or paired thorns are usually present at the leaf bases. Small,

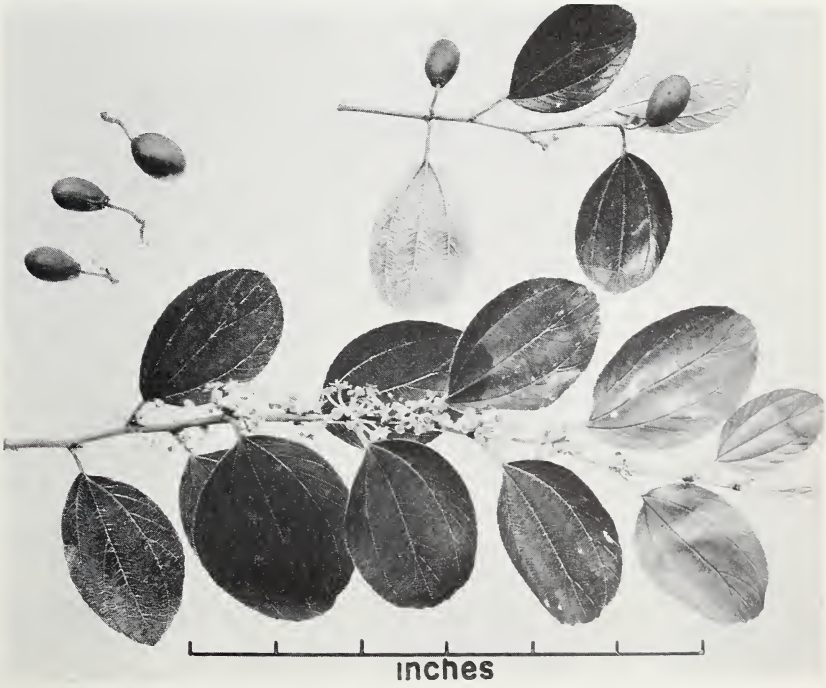

FIGURE 96.—The Indian jujube, *Zizyphus mauritiana*.

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foul-smelling, yellowish-white flowers are borne in clusters at the leaf axils. The orange to brown fruit is rounded or oblong in outline, and 0.5 to 1 inch in length. A layer of edible acid pulp surrounds the hard, central stone. The fruits vary in thickness and quality of the pulp, some of them being delicious in flavor whereas others are hardly edible. It is scarcely known in Puerto Rico but is well thought of on the adjacent Island of Vieques where selections have been made.

Propagation is usually by seeds, which germinate in 4 to 6 weeks. Layering and grafting are possible.

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LIST OF PLANTS BY BOTANICAL FAMILY

ANACARDIACEAE
- *Anacardium occidentale*
- *Spondias cytherea*
- *S. mombin*
- *S. purpurea*
- *S. purpurea* var. *lutea*
- *S. tuberosa*

ANNONACEAE
- *Annona cherimola*
- *A. diversifolia*
- *A. glabra*
- *A. montana*
- *A. muricata*
- *A. reticulata*
- *A. squamosa*
- *A.* hybrid (Atemoya)
- *Rollinia mucosa*
- *Uvaria lancifolia*

APOCYNACEAE
- *Carissa carandas*
- *C. edulis*
- *C. grandiflora*

ARACEAE
- *Monstera deliciosa*

BIGNONIACEAE
- *Parmentiera edulis*

BIXACEAE
- *Bixa orellana*

BOMBACACEAE
- *Durio zibethinus*

BROMELIACEAE
- *Bromelia pinguin*

CACTACEAE
- *Pereskia aculeata*

COMBRETACEAE
- *Terminalia catappa*

CUCURBITACEAE
- *Sicana odorifera*

DILLENIACEAE
- *Dillenia indica*

EBENACEAE
- *Diospyros discolor*
- *D. ebenaster*

ELAEAGNACEAE
- *Elaeagnus philippensis*

EUPHORBIACEAE
- *Antidesma bunius*
- *A. platyphyllum*
- *Phyllanthus acidus*
- *P. emblica*

FLACOURTIACEAE
- *Dovyalis abyssinica*
- *D. caffra*
- *D. hebecarpa*
- *Dovyalis* hybrid (*D. hebecarpa* x *D. abyssinica*)
- *Flacourtia indica*
- *F. inermis*
- *F. rukam*

GUTTIFERAE
- *Garcinia dulcis*
- *G. livingstonei*
- *G. mangostana*
- *G. xanthochymus*
- *Mammea americana*
- *Rheedia madruno*

LECYTHIDACEAE
- *Bertholletia excelsa*
- *Lecythis elliptica*
- *L. zabucajo*

LEGUMINOSAE
- *Inga laurina*
- *Inga vera*
- *Tamarindus indica*

MALPIGHIACEAE
- *Byrsonima crassifolia*
- *B. spicata*
- *Malpighia punicifolia*

MALVACEAE
- *Hibiscus sabdariffa*

MELIACEAE
- *Lansium domesticum*

MORACEAE
- *Artocarpus champeden*
- *A. communis*
- *A. integra*
- *A. odoratissima*
- *Ficus carica*
- *Morus alba*

MYRISTICACEAE
- *Myristica fragrans*

MYRTACEAE
- *Eugenia dombeyi*
- *E. jambos*
- *E. malaccensis*
- *E. uniflora*
- *Myrciaria cauliflora*
- *Psidium cattleianum*
- *P. cattleianum* f. *lucidum*
- *P. guajava*
- *P. guineense*
- *P. microphyllum*
- *Syzygium cumini*

OXALIDACEAE
- *Averrhoa bilimbi*
- *A. carambola*

PALMACEAE
- *Aiphanes minima*
- *Guilielma gasipaes*

PASSIFLORACEAE
Passiflora edulis
P. edulis var. *flavicarpa*
P. laurifolia
P. ligularis
P. mollissima
P. quadrangularis
P. van-volxemii

POLYGONACEAE
Coccoloba floridana
C. uvifera

PROTEACEAE
Macadamia ternifolia
M. tetraphylla

PUNICACEAE
Punica granatum

RHAMNACEAE
Zizyphus mauritiana

ROSACEAE
Chrysobalanus icaco
Eriobotrya japonica
Fragaria hybrids
Rubus albescens
R. florulentus
R. glaucus
R. macrocarpus
R. probus
R. rosaefolius
R. rosaefolius var. *coronarius*
R. shankii

RUBIACEAE
Genipa americana
Vangueria edulis

RUTACEAE
Casimiroa edulis
C. tetrameria
Triphasia trifolia

SAPINDACEAE
Blighia sapida
Euphoria longan
Litchi chinensis
Melicocca bijuga
Nephelium lappaceum
N. mutabile

SAPOTACEAE
Achras zapota
Calocarpum sapota
C. viride
Chrysophyllum cainito
C. oliviforme
Lucuma multiflora
L. nervosa
Malacantha warneckeana
Synsepalum dulcificum

SOLANACEAE
Cyphomandra betacea
Solanum hyporhodium
S. macranthum
S. quitoense

STERCULIACEAE
Cola acuminata
Sterculia apetala
S. foetida
Theobroma cacao

TILIACEAE
Grewia asiatica
Muntingia calabura

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